THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid	$3 00
Subscription, per annum, Foreign Countries	3 50
Single copies	25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, JULY, 1891.

ON the recommendation of the New York Railroad Commissioners a new system of ventilation is to be tried in a section of the Fourth Avenue Railroad tunnel, about half a mile in length. Briefly described, this system consists in the construction of a false roof with a longitudinal slot or opening to admit the top of the locomotive stacks. The smoke and cinders will thus be thrown into the upper part of the tunnel, above the false roof, and will be drawn out by forced draft.

THE Cape Cod Ship Canal, one of the largest projects of the kind in this country, has met with very varying fortunes. Several companies have been formed, and work has been actually begun upon the canal at several different times, but each time only to be stopped before any considerable amount had been done. The last company came to the end of its resources some time ago, and the Massachusetts Legislature has now given permission to a new company to undertake the work of constructing the canal. The Boston, Cape Cod & New York Canal Company, the new organization, has made very fair promises, and under the terms of the act is required to make a large deposit of money before obtaining its charter, a large part of this deposit to be forfeited in case the canal is not completed. The delay in the construction of this work is not altogether easy to understand, as its benefit to commerce would be undoubted, and there do not seem any serious difficulties to be overcome.

IRON production for June, as given in the monthly statement of the *American Manufacturer*, shows a considerable increase, the number of furnaces in blast June 1 being greater by 16 than on May 1, while the weekly capacity has increased by 31,213 tons. The principal increase is in the bituminous and coke furnaces, but there are also nine more charcoal furnaces than on May 1. The anthracite production shows practically no change. The greatest increase in production has been in the Pittsburgh District, but there has also been a considerable change in Alabama, in Virginia, and in the Shenango Valley.

As compared with June 1, 1890, the production of charcoal iron, estimated by the weekly capacity of the furnaces, shows substantially no change. The anthracite furnaces show a decrease of 18 per cent. in the capacity of those in blast, and the bituminous and coke furnaces a decrease of about 17 per cent. It may be said, however, that the furnaces are recovering from the depression which marked the early part of the year, and the prospects are for a steady if not very large increase during the last half of 1891.

WORK is now going on upon a line from Asheville to Rutherfordton, N. C., which is to be operated by electric motors. The dynamos furnishing the power will be run by water-power, the stations being located at convenient points. The distance between the two places is about 40 miles, and this is the longest electric railroad yet undertaken.

THE Navy Department has decided to call for new bids for Torpedo Boat No. 2, and they will be received until August 18 next. The boat will be of not over 120 tons displacement, and must be built in one year. The minimum speed is to be 24 knots an hour, although the boat may be accepted on 22 knots, and a bonus will be paid for every quarter knot attained over 24. Bids may be made either on the Department plans or on builders' own design.

IT is stated that the Navy Department is preparing to enter into an extensive course of experiments with torpedoes. A permanent Torpedo Board will be established, which will report directly to the Secretary, and under its charge tests will be made with the Whitehead, the Howell, the Hall and other auto-mobile torpedoes. The *Cushing* will also be thoroughly tested, with a view to possible improvements in the design of later torpedo-boats, and the Ericsson submarine boat *Destroyer* will be tried. The work of the Board will include means of defense as well as of attack, and devices for that purpose will be given a trial.

THE later reports received concerning the sinking of the Chilian iron-clad *Blanco-Encalada* by torpedoes do not give the advocates of those weapons of attack very much comfort. It appears that the ship was anchored, no torpedo nets were in place, no guns in readiness for use, and no guard boats stationed. The torpedo-boats were enabled to approach her so closely that voices upon the deck could be heard. It was entirely a surprise, and no time or opportunity was given to use any of the means of defense against torpedo attack, which are provided on all modern cruisers. Four torpedoes were launched by the attacking boats—instead of seven, as reported in first accounts—and as nearly as can be determined, two of them took effect, one of the others being lost altogether, and one striking a dock in the harbor. It is believed by a number of those concerned that, had even an ordinary lookout been kept upon the *Blanco-Encalada*, she would have escaped destruction.

THE opportunity for testing one of our new cruisers in actual war has passed by, the Chilian insurgents having surrendered the runaway steamer *Itata* without a contest. Of course war is to be deprecated, and it is well that a fight was avoided, but while the public generally

acknowledges that fact, it is somewhat in the position of a boy with a new knife, and would not have been sorry for a chance to see one of its new ships put to the test, a feeling not unnatural, though somewhat illogical.

In the chase the *Charleston* proved herself a good sea boat and a fast steamer. The criticisms made on her in some quarters for not catching the *Itata* are hardly well founded, and indeed are made chiefly by persons who do not realize the difficulty of finding a ship which has the start to begin with, and the whole Pacific Ocean on which to select her course. The chase must be wholly by guess-work, and the chances are tremendously against the pursuing ship, no matter how great an advantage she may have in speed.

THE most important naval event of the past month was the letting of the contract for Cruiser No. 13, which is substantially a sister ship to Cruiser No. 12, or the "Pirate," as she is popularly called. Contrary to general expectation, the bid of the Cramp Company, which is building No. 12, was not the lowest, and the contract goes to the Bath Iron Works. That concern is comparatively new, as far as the building of large steel ships is concerned, but has already three naval contracts in hand, two of the smaller cruisers and the Ammen ram. The Bath Works have an excellent plant, and are said to be doing very good work. The engines of the new ship will be built at the Morgan Works in New York.

Cruiser No. 13 was the only large ship authorized this year. The only ships authorized which are not now under contract are Torpedo-boat No. 2; the torpedo cruiser, for which no bids were received; Dynamite Cruiser No. 2, which will not be begun until some decision is reached as to the success of the *Vesuvius;* and the so-called "Thomas Monitor," which has been practically dropped and will not be built.

THE first of the 12-in. steel rifled guns built for the Army has been delivered at the proving ground at Sandy Hook, and the trials will begin as soon as it can be mounted. The gun has been built at the Watervliet Arsenal, where several others of the same caliber are now under construction to be used in the coast defense works, which will be built at Boston and New York.

This gun is a somewhat heavier piece than the Navy 12 in., being a little longer. It will carry a projectile weighing about 1,000 lbs., and the full service charge will be 440 lbs. of powder. The initial velocity of the shot is expected to be 1,940 ft. per second. It will be exceeded in weight and in initial velocity by the new Navy 13-in. gun, but is the heaviest piece yet completed for the Army, although the construction of several 16-in. guns will be begun as soon as the forgings are ready.

RAPID TRANSIT IN NEW YORK.

THE Rapid Transit Commission which has been considering the question of additional facilities for passenger transit in New York has made a preliminary report, giving its conclusions so far as the west side of the city is concerned. Briefly stated, they are that there is need of a line which will in part parallel the existing Elevated road, but will also extend beyond that line to the northern limit of the city, and will serve a district which is now delayed in its development by the lack of proper facilities for reaching it. So far the Commission holds only what almost every one in the city believes; but it has not gone as far as many citizens wish, and has approved only a single line, where most people who have thought over the matter carefully believe that two are needed. That the Commission's line is a good one few will be inclined to dispute, almost the only question being whether the single route approved is sufficient.

As to the kind of road to be built, the report makes two radical departures: the first in recommending a deep tunnel or underground line, and the second in approving of electricity as the motive power. In both of these the members were doubtless influenced by the reports of the successful working of the new City & South London line in London, an electrical line wholly underground and for most of its length from 50 to 60 ft. below the surface.

That a deep tunnel is practicable in New York, and at a cost upon which the traffic will pay interest, may be admitted without much dispute. There may be some objection to traveling underground at first, but this will soon disappear if there is a substantial gain in time. As to electricity as a motive power there will be more difference of opinion, especially when the particular system to be adopted comes to be considered.

Meantime the Commission's engineers are making surveys for its line. When the matter takes final shape, however, legal obstacles are much more likely to delay the work than engineering difficulties.

THE MASTER MECHANICS' CONVENTION.

IT is said that in some countries, where the inhabitants make much pretense of religion, their prayers are written on revolving sign-boards which are placed by the roadside, and that in order to save time in saying them, the devotees give the board a twirl with the ejaculation of Sam Weller, that "them's my sentiments." The late meeting of the Master Mechanics was so much like many which have preceded it, that in commenting on it we are tempted to refer our readers back to what has been written in previous years, and add the remark that what was written then will apply to the meeting which has just been held.

There were this year perhaps a few more of the same kinds of people present that usually attend the meetings. The master mechanic was there in force. The superintendent of machinery was in a minority, apparently doubtful whether it was not beneath his dignity to be present and take part in the proceedings. The "representative" of various manufacturing interests was there in a large majority; the wives, the sisters, the cousins, and the aunts of the masculines in attendance decorated the borders of the assemblage as plots of flowers ornament a vegetable garden. There was an exhibition of a great variety of appliances, with attendants who could talk like water-wheels. The inventor was there, as solicitous of his creation as a cow is of its calf. The "crank" lingered on the outskirts, hollow-eyed and anxious. There was an entertainment committee with extended hands for "assessments." There were carriages and flowers for the ladies, dancing by night and music by day—young ladies and old, flirtatious girls and coy maidens, dudes and hard-handed sons of toil. The ocean was there, and the people bathed and fished in it, and told fish stories afterward. There was a laboratory in a back room, where the laws of chemical

affinity were illustrated by inverting a metal frustrum of a cone over a glass vessel of similar form, and then agitating the contents. When the reaction was complete the experiment was continued by the audience, who put themselves outside of the chemical combination. In some cases another reaction occurred about a half hour afterward, attended with more or less ebullition of jollity.

The following is a list of the reports which formed the programme of the meetings, with the committees thereon :

1. Exhaust Pipes, Nozzles and Steam Passages. *Committee :* C. F. Thomas, A. W. Gibbs, L. C. Noble, F. C. Smith, John Y. Smith.
2. Testing Laboratories, Chemical and Mechanical. *Committee :* George Gibbs, G. W. West, L. S. Randolph, D. L. Barnes.
3. Advantages and Disadvantages of Placing the Fire-box above the Frames. *Committee :* F. B. Griffiths, James Macbeth, W. A. Foster, A. G. Leonard, L. F. Lyne.
4. Relative Value of Steel and Iron Axles. *Committee :* John Mackenzie, J. S. Graham, John S. Cook, E. B. Wall, Thomas Shaw.
5. Purification or Softening of Feed-Water. *Committee :* W. T. Small, H. Middleton, A. W. Quackenbush, J. B. Barnes, John W. Hill.
6. The Present Status of the Car-Coupler Question. *Committee :* John Hickey, G. W. Rhodes, Sanford Keeler, R. H. Blackall, M. N. Forney.
7. Examination of Locomotive Engineers and Firemen. *Committee :* W. H. Thomas, John Player, F. D. Casanave, J. W. Luttrell, L. R. Pomeroy.
8. Operating Locomotives with Different Crews. *Committee :* Ross Kells, W. W. Reynolds, W. F. Turreff, C. G. Turner, John A. Hill.
9. Locomotives for Heavy Passenger and Fast Freight Train Service. *Committee :* P. Leeds, James Meehan, E. M. Roberts, C. E. Smart, W. A. Smith.
10. Electrical Appliances for Railroad Use. *Committee :* T. W. Gentry, G. B. Hazlehurst, Albert Griggs, John Ortton.
11. Standards of the Association. *Committee :* William Swanston, William Garstang, C. H. Cory, J. S. McCrum, Thomas Shaw.
13. Air-Brake Standards and Inspection and Care of Air Brakes. *Committee :* R. C. Blackall, G. W. Stevens, D. Clark.
14. On Bringing Conventions Closer Together. *Committee :* O. Stewart, Charles Graham, D. Clark, G. W. Stevens, John Mackenzie.
15. Subjects for Investigation and Discussion. *Committee :* William H. Lewis, John Wilson, P. H. Peck.
16. Disposal of Boston Fund. *Committee :* J. N. Lauder, J. N. Barr, Angus Sinclair.

On another page we give a brief report of the proceedings. There was nothing very remarkable about them. The discussions were generally rather tame, excepting on the subject of compound locomotives. Representatives of the Baldwin and Schnectady locomotive works presented the claims of two and four-cylinder locomotives, but the members generally were rather chary of expressing opinions. Altogether, there is not much to say of the meeting, excepting that it was held—in the usual way. The attendance was a little larger than heretofore, showing a steady growth in that respect. The reports were neither better nor worse than usual—none of them were remarkably good, although some were uninteresting.

One member was sat upon by the graduates of technical schools for saying that he could not, in his experience, recall an instance in which any one by the use of an indicator had found out anything about a locomotive which was worth knowing. In the discussion which followed some of those who took part in it attempted to crush this member, as a housewife rolls out incipient pie crust. He still lives, however.

The disposition of the Boston fund was, it will be seen, the subject of a special report by a committee. As probably only the older members of the Association know how this fund originated, it may be well to say that when one of the conventions was held in Boston quite a number of years ago a local entertainment committee organized there had a surplus left after all expenses were paid. This was donated to the Association, and has been drawing interest ever since. The money promised to be a source of trouble to the Association, and for that and other reasons it was desirable to make some disposition of it. This has been done by creating a scholarship in the Stevens Institute of Technology, which is open to the son of a master mechanic who passes the best examination. The fund thus becomes the source of perpetual benefaction to descendants of the present members. It is to be regretted that a part, at least, of the large sums of money which are expended each year for the entertainment of members cannot be diverted into a like channel.

The place of meeting for next year has wisely been referred to a joint committee of the Master Mechanics' and the Master Car Builders' associations, and it is proposed to begin the convention of the latter body on Wednesday, and of the former on Monday, so that from the beginning of the session of the one association to the end of that of the other will occupy only eight days. A good deal of complaint is now made of the time consumed by the two meetings. A better plan than that proposed would seem to be to hold the first session of the Car Builders' meeting on Monday evening, and thus dispose of the routine work of the first session. Then devote Tuesday and Wednesday to this Association. On Wednesday evening the first session of the Master Mechanics could be held, and Thursday and Friday devoted to its meetings. In this way the meetings of the two associations could be held in four days, which would save much time and money.

ENGINEERING AT THE EXHIBITION OF 1893.

THE movement for the establishment of special headquarters for Engineers and of a special department of Engineering at the great Exhibition of 1893 assumed form at a meeting held in Chicago in May, at which there were represented the American Society of Civil Engineers ; the American Society of Mechanical Engineers ; the American Institute of Mining Engineers ; the American Institute of Electrical Engineers ; the Canadian Society of Civil Engineers ; the local Engineers' societies of Boston, Philadelphia, Pittsburgh, Cleveland, Chicago, St. Louis, St. Paul, Minneapolis, the South, Kansas City and Montana. All of these had appointed delegates, and a large proportion were present.

After due consultation the movement was given an organization by the choice of a President and Executive Committee, and the delegates from the various societies resolved to assume the name of the "General Committee of Engineering Societies, Columbian Exposition." The objects of this Committee were defined as follows :

1. To provide on behalf of the Engineering Societies represented on this Committee Engineering Headquarters for members of all Engineering Societies of the world, who may visit Chicago during the World's Columbian Exposition in 1893.
2. To promote an International Engineering Congress to be held in Chicago in 1893 under the auspices of the World's Congress Auxiliary of the World's Columbian Exposition.

The management was placed in capable hands, Mr. Octave Chanute being chosen President, with the following members of the Executive Committee : E. L. Corthell, E. M. Izard, William Forsyth, C. L. Strobel, Robert W.

Hunt, John W. Cloud and D. J. Whittemore. A Secretary and Treasurer are to be chosen.

The Committee also passed a resolution to the effect that "the importance of Engineering entitles it to the place of an independent department in the World's Congresses, to be held in 1893, under the auspices of the World's Columbian Exposition." This seems to be so plain as hardly to admit of discussion.

It may be noted also that the Master Car-Builders' and the Master Mechanics' Associations have both passed resolutions in favor of co-operation in the Exhibition, and have appointed committees to outline the form which their assistance should take.

It is to be hoped that all classes of engineers will assist, and that they will work together in securing a proper representation at the Exhibition, which will, indeed, be largely a showing of the result of their labors.

ENGLISH AND AMERICAN LOCOMOTIVES.

THE *Engineer* of May 22 contains another article on the above subject, in reply to one which appeared in the May number of this JOURNAL. The answer will be deferred for another month, when we expect to give some data bearing upon the subject.

At the conclusion of his article the editor of *The Engineer* says:

> Our contemporary reverts to a proposition he made long since, which strikes us as being a very curious proposition. It is that we should publish drawings of a large English express passenger locomotive, and the same of a goods engine. . . . It would appear that the RAILROAD AND ENGINEERING JOURNAL is in ignorance of the fact that we have published drawings and particulars of all the best English locomotives, and that we continue to publish such drawings, representing every change in practice, from time to time, as occasion arises. Precisely what more our contemporary needs for the purposes of comparison we are at a loss to understand.

We are not in ignorance of the fact that *The Engineer* from time to time has published admirable engravings of English locomotives. What we do not know is, which of them, in the judgment of our contemporary, fairly represents British practice of the present day. If the editor of *The Engineer* will point out which of the heavy passenger engines that have been illustrated in its pages represents that practice, it will be possible then to compare its design and construction with that of an American engine of like weight and capacity. It should be added that, as compound locomotives are not very extensively used in England, and are hardly out of the experimental stage here, they should be excluded in making such a comparison.

THE VAUCLAIN COMPOUND LOCOMOTIVE.

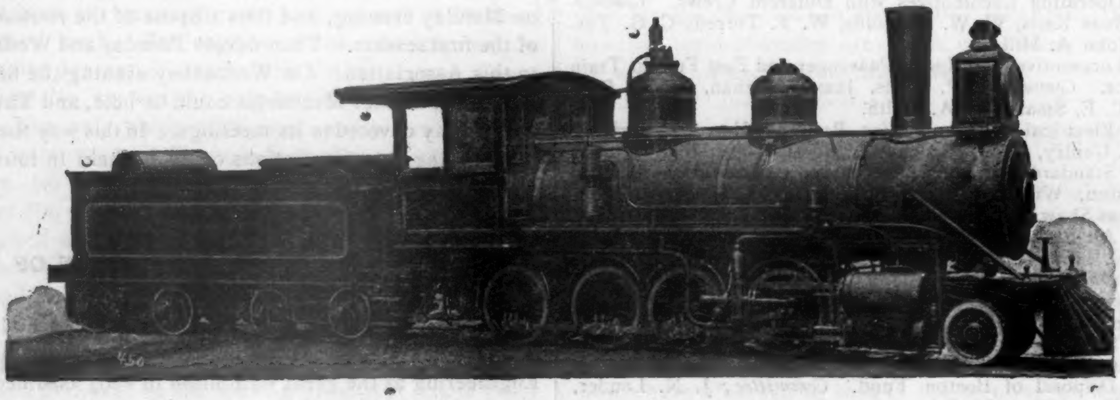
WE have received from the inventor of this locomotive a communication in which he disputes the statements made by M. Mallet in the article which was published in our April number. In this article M. Mallet, in speaking of Mr. Vauclain's design, said that:

> The lowest point of the large cylinder is 22 in. below the common axis, and unless the cylinders are inclined, which is contrary to American custom, the wheels could hardly have a diameter less than 56 in., which is greater than is generally used for a consolidation engine, where the wheels are usually 48 or 50 in. in diameter.

Mr. Vauclain has written that:

> We (that is, the Baldwin Locomotive Works) are making compound locomotives of the four-cylinder type with driving-wheels 24 in. diameter and upward, and also for all gauges of track from 20 in. up to 5 ft. 6 in., the widest now in use in South America.

He has sent us some photographs from which the engravings herewith have been made, and which illustrate some features in the construction of this class of locomotives.



COMPOUND CONSOLIDATION LOCOMOTIVE, VAUCLAIN SYSTEM.

Fig. 1 represents a compound consolidation locomotive of the Vauclain type. In this it will be seen that the small, or high-pressure cylinder is below, and the large, or low-pressure cylinder is above. Fig. 2 shows the front end of an engine with the same arrangement of cylinders, but with frames outside of the wheels. Fig. 3 represents an engine with the same kind of frames, but with the cylinders reversed in their relative positions. Fig. 4 shows a similar view of an engine of the American type, but with the high-pressure cylinder above and the low-pressure cylinder below. All these engines, excepting the last one, have wheels smaller than 56 in. diameter, showing that the plan is adapted to be used with small wheels and horizontal cylinders.

At the Master Mechanics' Convention, held in June, Mr. Vauclain stated that the firm he is connected with has orders for over 40 compound locomotives of his four-cylinder type. During a recent visit to the Baldwin Locomotive Works we found a large number of these engines in progress, and apparently their manufacture is an established branch of the business of the firm.

In some recent trials Mr. Vauclain reports an economy of from 35 to 40 per cent. of his type of engine over some non-compound engines. This, if confirmed by regular

practice, will be an extraordinary result, and will place the economy of the compound locomotive beyond further dispute. He also says :

Another item of interest to you will be the reliable data I have gathered in relation to piston rods. We have never had any complaint from this source, and M. Mallet can rest secure so far as that is concerned. When out with the last large consolidation, I ran the engine 10 miles, using high-pressure steam in the low-pressure cylinders, and had to keep sanding the rail all the time in order to keep to the rail—with no kinking of the piston-rods at all.

These statements, and the engravings, will be sufficient to show that M. Mallet's criticism was based on a misunderstanding.

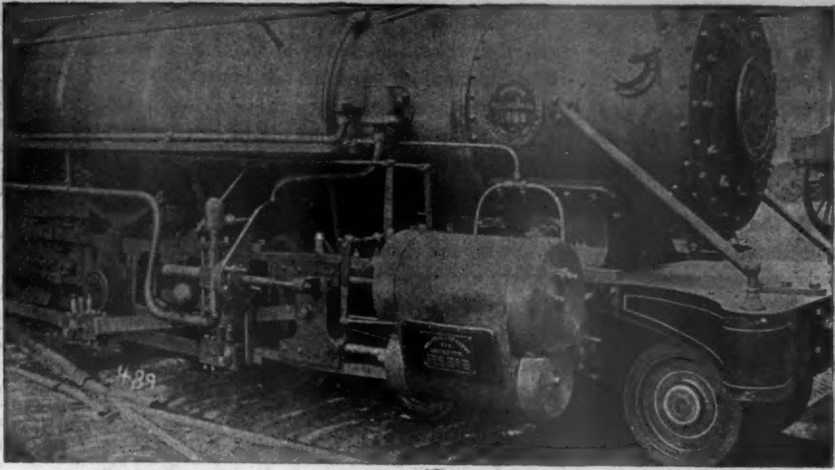


Fig. 2.

THE TRIAL OF THE VESUVIUS.

THE recent trial, in Chesapeake Bay, of the dynamite cruiser *Vesuvius*, although not successful in determining the actual value of that vessel, has yet clearly demonstrated to those who have studied the experiments, the tremendous force of this arm of warfare.

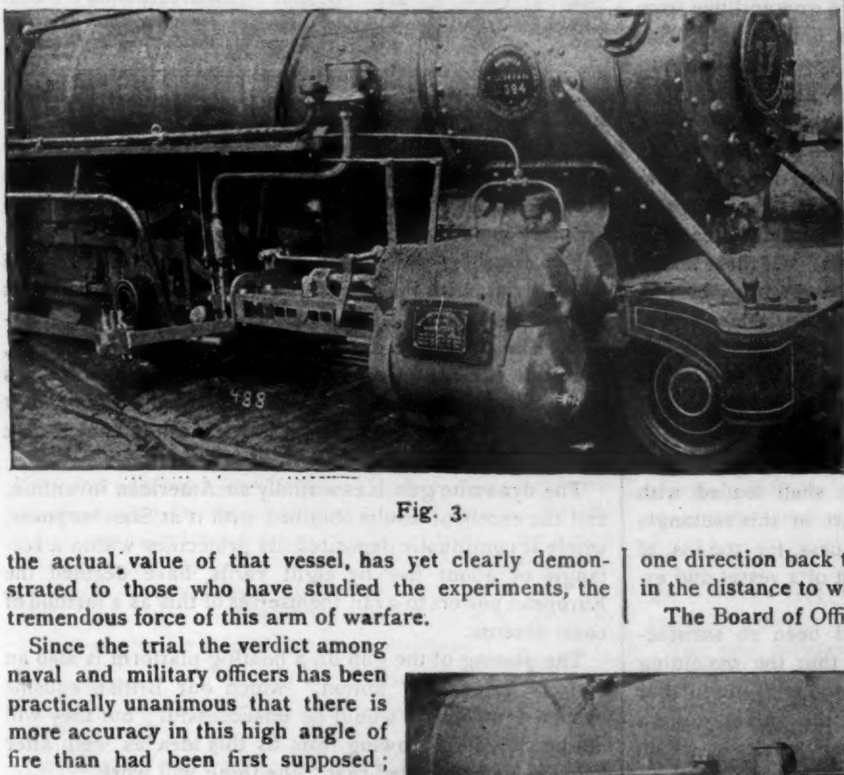


Fig. 3.

Since the trial the verdict among naval and military officers has been practically unanimous that there is more accuracy in this high angle of fire than had been first supposed ; and if the experiments have had no other success, they have at least succeeded in creating among army and navy men ten times as many advocates for the dynamite cruiser as formerly existed.

It is unfortunate that the trial was conducted under circumstances tending to make apparently a target-practice out of what was in reality an operation for determining the ranges of the pneumatic guns.

It was well known beforehand that the tubes would carry the projectiles to a distance much further than that reached by any of those fired in Chesapeake Bay. It was also well known beforehand that the principle upon which the pneumatic gun is constructed requires and presupposes a table of ranges, determined by experiment—an operation that had not been performed for the three pneumatic tubes prior to the visit of the Board.

The compressed air, which is the expelling power, and which is always under constant pressure, is admitted to the base of the projectile by the opening of a valve ; and therefore it necessarily follows that the period of time during which the valve remains open, or even the amount of its aperture that is opened, directly influences the range of the projectile. Indeed, so minutely does the amount of time occupied in opening and closing the valves affect the range, that in the late trial it was noticed that the slight loss of motion due to the change in turning the valve from one direction back to the other direction became apparent in the distance to which the projectile was carried.

The Board of Officers who conducted the first trial con-

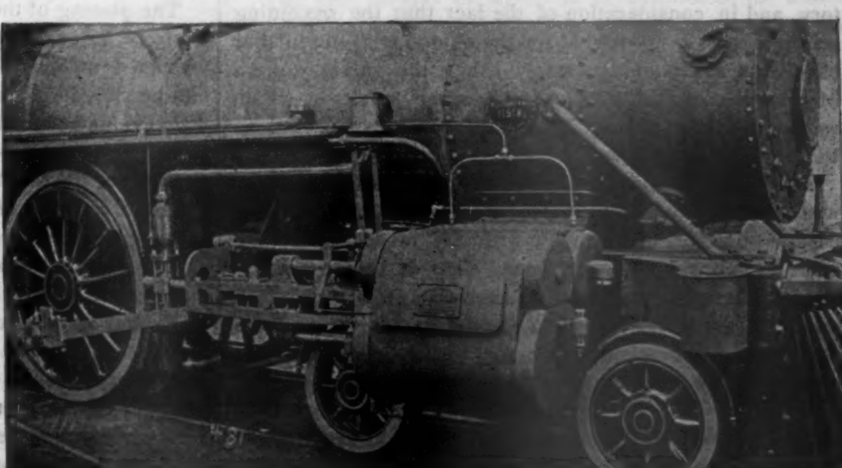


Fig. 4.

sidered that the tests were not exhaustive enough to warrant them in reporting upon the actual efficiency of the vessel; and the same Board are to conduct a second series of experiments. This is particularly fortunate, since these gentlemen will have profited by their observations made during the trial in Lynnhaven Roads.

Two essential points have been clearly demonstrated—first, that it is absolutely necessary to know approximately the distance of the object to be struck; and, second, the valve-system must be absolutely arranged to admit at all times the required amount of compressed air, and no more.

As a favorable offset to the fact that these two necessities exist, it has been distinctly shown that the line of fire from the pneumatic guns is excellent, and that the pitching of the vessel, even in a comparatively rough sea-way, but little affected the range of the projectile. These two points were the ones upon which the greatest doubt had existed in the minds of naval men, and the trial, no matter how unsatisfactory in other respects, has entirely dissipated these doubts.

In all but 26 projectiles were provided for the ranging and subsequent testing of the three tubes. On May 18, the first day, 11 of these were fired to find the range of the guns, six being fired from the starboard gun and five from the middle gun. The port gun was not tested. This number of shots was, as a matter of course, inadequate to determine an accurate table of ranges, and therefore attention was confined to only these two guns.

On May 19 an informal target-practice was made by firing nine of the remaining shots at known distances from the target. Six of these were fired with the Vesuvius stationary, and three of them with the Vesuvius steaming toward the target at the rate of 12½ knots. Of these shots, a table of which is given below, three were in exact line, one being a bull's-eye. The greatest deviation to the right or left of the line of fire was 52 yards at a distance of a mile, and the greatest amount short of the target was 28 yards, at a distance of half a mile. Six of the nine shots would have destroyed a vessel the size of the *Dolphin*. The modern battleship would present a rectangle of about 150 yards by 40 yards. If a shell loaded with dynamite can be dropped on any part of this rectangle the shot should be considered a success, for 500 lbs. of dynamite falling that close to any part of a vessel and exploding is bound to create havoc.

Inasmuch as this informal trial had been so satisfactory, and in consideration of the fact that the remaining six projectiles were needed for the official trial, no further effort was made to accurately range the valves, and on May 20 the official trial was made, the results of which were not, unfortunately, in any degree as successful as those of the day before.

A table of the shots made on May 20 is also given herewith. Only two of the shots fired this day would, to a casual observer, or upon an ordinary inspection of the table, be considered good ones. One of them, the first shot fired, was thrown while the vessel was going at a speed of 12½ knots toward a stationary target, and the other, the fourth shot, while the vessel was going at a speed of 17½ knots, and at a target moving at a rate of 10 knots.

The other shots of this day's trial were, at first glance, apparently entirely unsuccessful, one going 250 yards short and one 300 yards beyond the target. Still when we consider that the "target" in question was an ordinary

TABLE OF SHOTS, MAY 19, 1891, "VESUVIUS."

Number of Shot.	Dist. of Target.	Dev. from line, yds. over or under.	Range, yds. over or under.	Remarks.
1.	1 mile.	0.	52 over.	*Vesuvius* stationary and distance known.
2.	¾ "	16 L.	48 over.	
3.	½ "	0.	Bull's-eye.	
4.	1 mile.	52 L.	32 over.	*Vesuvius* steaming toward target at rate of 12½ knots.
5.	¾ "	0.	24 over.	
6.	½ "	16 L.	28 short.	
7.	1 mile.	24 L.	4½ short.	*Vesuvius* stationary and distance known.
8.	¾ "	15 L.	35 short.	
9.	½ "	10 L.	28 short.	

TABLE OF SHOTS, MAY 20.

1.	1 mile.	0.	56 over.	*Vesuvius* steaming 12½ knots toward target.
2.	¾ "	16 R.	104 over.	
3.	½ "	24 R.	24 short.	
4.	1 mile.	20 L.	16 short.	*Vesuvius* steaming 17½ knots toward a cutter towed by the *Cushing* at 10 knots.
5.	¾ "	0.	300 over.	
6.	½ "	8 L.	275 short.	

naval cutter, probably not over 2 ft. in height and 30 ft. in length, some of these shots appear to better advantage when analyzed according to the effect they would have produced had they been fired at a target the size of an ordinary man-of-war.

For example, the second shot, fired on the day of the official trial, with the target at a distance of 0¾ mile, went 16 yards to the right, and struck 104 yards beyond the target. The tubes are placed at an angle of 18° elevation, and with the above data it can be easily seen that this shot, that figures apparently as a poor one, would, if it had been aimed at the midship line, certainly have struck some part of a vessel the size of the *Newark*.

The dynamite gun is essentially an American invention, and the excellent results obtained with it at Shoeburyness, where it continually deposited its projectiles within a rectangle of about five by eight yards, have decided the European powers to avail themselves of this as a method of coast defense.

The placing of the gun on a floating platform is also an entirely American "notion," which our British cousins hastened to declare would be unsuccessful; but they will not be slow in borrowing from us this idea as well, after we have demonstrated that "the thing will work."

The Fiske range-finder, which was mainly invented on account of the trouble that that officer foresaw to obtain an exact distance of ranges aboard this vessel, will at all times give the distance of the target from the vessel. It is now reported that before the next and final trial of the little vessel, this range-finder is to be placed aboard of her; and if this be done, one of the disadvantages that before existed will have been overcome, as the distance of the target at any time will be approximately shown.

Many officers of the Navy, who before the time of this trial had little interest or belief in the efficiency of the vessel, have now become enthusiastic over her performance, and are confident that before the time of the next trial American invention will have devised a more perfect

system of discharging valves, and that her next experiments will be an entire success.

The vessel will receive a fair, patient and impartial trial from the Board appointed to inspect her, and criticism should be suspended or, at least, condemnation should be withheld until it has been decided that the supposed defects may not be necessary ones.

NEW PUBLICATIONS.

FOURTH ANNUAL REPORT OF THE BOARD OF PUBLIC WORKS OF THE CITY OF DULUTH, MINN. *For the Year ending February 28, 1891.* Duluth, Minn.; issued by the City.

This report shows that a great variety of public work has been executed in Duluth during the past year, but its chief interest is in what is proposed for the future. The most important work is a tunnel under the ship canal on Minnesota Point—the main entrance to Duluth harbor—on which question a report by Mr. William Sooy Smith is given. After considering the requirements of the case, he recommends the building of a tunnel with three galleries, two to carry one railroad track each, the third a street railroad track and a footway for passengers. The tunnel is presented as the best plan for securing a crossing which is very much needed. For the approaches a 10 per cent. grade is recommended, the traffic to be worked by a rack-rail locomotive on the Abt system.

It is understood that these recommendations will probably be adopted and a tunnel built.

WHO OWNS THE LAKE BEDS? By F. Hodgman. Battle Creek, Mich.; published by the Author.

This is a reprint of a paper read before the Michigan Engineering Society at its last meeting on a subject which has caused much controversy in the Northwest and, in one case at least, has led to litigation of considerable importance. The question refers to the beds of the small lakes found on the public lands, or lands which have been public, within the regions subdivided by the United States Survey. After a careful examination of the authorities and of Government practice Mr. Hodgman concludes that the beds of non-meandered lakes belong to the owners of the adjoining land; that the beds of meandered non-navigable lakes belong to the General Government; that the beds of navigable lakes belong to the State. Where the waters of a lake recede permanently, the land so gained belongs to the owners of the adjoining land.

The subject is a somewhat curious one, and is of interest to land surveyors and land-owners in many places.

BRICK PAVEMENT. *The Inauguration and Execution of the Work; the Manufacture of Brick; with Tables of Experiments and Tests.* By C. P. Chase, City Engineer, Clinton, Ia. (Indianapolis; *Paving and Municipal Engineering*; price, $1).

The use of brick for street pavements is rapidly extending in the West, and especially in those sections where stone suitable for paving purposes is not easily obtainable. Doubtless its use would be still more extended were engineers better informed as to the qualities of the material, its capabilities and the reasons in favor of its employment. Wood pavements have not proved generally durable; asphalt is expensive in many sections of the country, and stone is also expensive when it has to be transported long distances overland. Engineers in many cities and towns are therefore interested in knowing what has been done with brick, how far it can be relied on under light and heavy traffic, what is the best quality for street use, and other points in relation to it.

This information Mr. Chase has sought to present in a concise form, his book being, as he says, not for those who have "been through the mill," but rather for those who are looking for knowledge and advice. The book contains first a preliminary section on the general question of paving, including preparation of the roadway and foundations, and then the more special part on paving brick and the best methods for using it. This includes a number of tests of brick and comparative tables showing the strength of bricks of different makes and their relative standing in other respects. There is also a description of various methods employed in laying pavements, with notes of experience with such methods. These are made clearer by illustrations.

As to the merits of brick pavements, Mr. Chase gives a table of comparative excellence of various paving materials based upon the latest experiments and facts taken from actual service, which is as follows:

	Relative Rank of Materials.				
Qualities.	1.	2.	3.	4.	5.
Durability under traffic.	Granite	Brick	Asphalt	Sandstone	Wood
Cost	Brick	Wood	Sandstone	Asphalt	Granite
Action of elements	Brick	Granite	Sandstone	Asphalt	Wood
Noise and dust	Asphalt	Brick	Wood	Granite	Sandstone
Repairs	Brick	Granite	Sandstone	Asphalt	Wood
Service on grades	Granite	Brick	Sandstone	Wood	Asphalt
Health	Asphalt	Granite	Brick	Sandstone	Wood

The concluding—and not the least valuable—part of the book is a complete set of specifications for brick paving. These have been used in actual practice, have stood the test of experience, and seem to be very complete and satisfactory in form and details. They will undoubtedly be of much service to city engineers and others who have to prepare for using such pavements for the first time.

GEORGE P. ROWELL'S BOOK FOR ADVERTISERS. (New York; George P. Rowell & Company; price $1.)

This book contains a number of lists of papers and other information based upon the long experience of the publishers in the business. While there are some mistakes in it, it must be of great service to the general advertiser who has not the time or opportunity to make himself acquainted with the papers through which he wishes to address the public. The special advertiser, who uses class or trade papers, has a narrower field, and can more easily work on his own account, but he also may find good advice.

The total number of periodical publications in the United States and Canada is given in this book as 19,373. New York has over 10 per cent. of these, or 1,958, and the number gradually decreases until we come to Alaska, which supports 3. The labor of keeping up a current acquaintance with nearly 20,000 papers can hardly be estimated, and it can only be accomplished by a carefully arranged system.

BOOKS RECEIVED.

Occasional Papers of the Institution of Civil Engineers. London, England; published by the Institution. The present issue includes papers on Authorities on the Steam Jacket, by Professor R. H. Thurston; Machine Stoking, by J. F. Spencer; Influence of Heat on the Strength of Iron, by Professor Martens; the Port of Swansea, by R. Capper; Auxiliary Engines, by W. H. Allen; Governors and Fly-Wheels, by Professor Dwelshauvers-Dery; the Von Schmidt Dredge, by George Higgins; Abstracts of Papers in Foreign Transactions and Periodicals.

Boiler Tests: Embracing the Results of 137 Evaporative Tests, Made on 71 Boilers, conducted by the Author. By George H. Barrus, S.B. Boston; published by the Author (price $5). This book is received too late to have the careful review which it requires given in the present number. It is a volume of 280 pages, with many illustrations.

Transactions of the Denver Society of Civil Engineers: Volume II, July-December, 1890. Denver, Col.; published for the Society.

Proceedings of the Third Annual Convention of the Iowa Society of Civil Engineers and Surveyors, held at Des Moines, December 30 *and* 31, 1890. Glenwood, Ia.; published by the Society; Seth Dean, Secretary (price, 35 cents).

Cornell University, Agricultural Experiment Station: Bulletin 27, *May,* 1891. Ithaca, N. Y.; published by the University.

University of Illinois, Catalogue and Circular. Champaign, Ill.; published by the University.

Purdue University: Annual Register, 1890–91, *with Scheme of Study for* 1891–92. Lafayette, Ind.; published by the University.

A Treatise on the Calkins Steam Indicator, with Descriptions of Calkins' Graduated Pantograph, Polar Planimeter, etc., etc. New York; the Engineers' Instrument Company (price, $1.50). This book is reserved for more careful review than time will permit in the present number.

TRADE CATALOGUES.

Catalogues and Price Lists of the Brown & Sharpe Manufacturing Company, and of Darling, Brown & Sharpe. Providence, R. I. This is a new edition of the catalogue of these well-known firms, containing several additions in the way of new machines, etc., not included in previous issues.

The Swenson Patent System of Evaporation by Multiple Effects. The Fort Scott Foundry & Machine Works Company, Fort Scott, Kansas.

The Star Ventilator: Illustrated Catalogue. Merchant & Company, Philadelphia.

ABOUT BOOKS AND PERIODICALS.

AMONG the new books in preparation by John Wiley & Sons is STONES FOR BUILDING DECORATION, by George P. Merrill, of the National Museum at Washington.

A very neat pamphlet called OVER THE CINCINNATI SOUTHERN was issued by the Cincinnati, New Orleans & Texas Pacific Company on the occasion of the Civil Engineers' Convention in Chattanooga. It contained a brief account of the road, with view of the Kentucky River Bridge and of Lookout Mountain, and a map giving also a profile of the road and showing the geological formations of the country. It was an excellent traveling companion.

In HARPER'S WEEKLY for June 10 there is a fine double-page portrait of Thomas A. Edison in his laboratory. Other recent numbers have had illustrated articles on the Chicago Parks, on the Adirondack Forests, and on the new Boulevard Tunnel under the Chicago River.

The May number of the JOURNAL of the American Society of Naval Engineers has articles on Trial Trips, by Chief Engineer N. P. Towne; Preservation of Marine Boilers, by Assistant Engineer S. H. Leonard; Engine Room Signals, by Assistant Engineer H. P. Norton; Trial of the *Bennington,* by Assistant Engineer Albert Moritz; Economic Marine Propulsion, by Chief Engineer John Low; Development of Cylindrical Heads for Boilers, by Assistant Engineer H. G. Leopold.

Almost every healthy man takes an interest in some kind of outdoor amusement, and accordingly every one will find something to suit him in OUTING for June. There are also some entertaining notes of travel. The military article for the month is on the Massachusetts Volunteer Militia, beginning with the companies of nearly 200 years ago—for Massachusetts military history runs back almost to the first settlement of Plymouth and Boston.

The JOURNAL of the New England Water-Works Association for June has several interesting papers and discussions. The one which has the most general importance is on Typhoid Fever in its Relation to Water Supplies, by Mr. H. F. Mills, of the Massachusetts State Board of Health.

The article in Mr. Child's South American series in the July number of HARPER'S MAGAZINE is on Paraguay. Colonel Dodge writes of the Cowboy and the Mexican Vaquero in his series on American Riders. The illustrations and the miscellaneous articles make this a most excellent summer number.

Probably the papers which will attract most attention in the June ARENA are Editor Flower's on Society Exiles and Camille Flammarion's on the Unknown. One of special value to engineers is on Irrigation in the Northwest, which is the result of careful study of the question.

The June number of the LEHIGH QUARTERLY will be an especially interesting one to graduates of the Lehigh University, containing several articles on the University itself and student history. Among the general articles are Reading and Indexing, by Professor Ira O. Baker; Nitro-Glycerine, by Albert Eavenson; Wrought iron Compression Members, by Henry S. Prichard; the Telephone, by J. Z. Miller.

The range of selection in the ECLECTIC MAGAZINE for June is shown by the fact that it contains articles from the *Gentleman's Magazine,* the *Contemporary Review,* the *Nineteenth Century,* the *Fortnightly Review,* the *National Review,* the *Saturday Review, Blackwood's Magazine,* the *Spectator,* the *Academy,* and the *New Review*—a list which pretty well covers the English magazines of standing.

Wool Spinning and Weaving; Sanitary Improvement in New York; Agricultural Experiment Stations, and Man and the Glacial Period are the leading articles in the POPULAR SCIENCE MONTHLY for July. The first one named is one of the series on American Industries, which has formed a feature of this magazine since the beginning of the year.

The more serious articles in BELFORD'S MAGAZINE for June are on the Wage System, by Eva McDonald; on Physical Culture, and on Foreign Trade and Reciprocity Abundance of reading is also provided for those who look for amusement rather than instruction in a magazine.

The April number of the SCHOOL OF MINES QUARTERLY is chiefly a mining number, and has several valuable articles on mining and metallurgy.

In the July number of SCRIBNER'S MAGAZINE Foster Crowell gives an Engineer's Glimpse of Hayti, including some interesting particulars concerning that fertile but very uneasy island. The steamship article is on Speed, and is by A. E. Seaton. Impressions of Japan, some stories of Mexican outlaws, and some very readable stories and other lighter matter complete the number.

A quarterly journal has been started in Chicago to advocate the use of brick for paving purposes. BRICK ROADWAYS is the appropriate name, and it is edited by Charles T. Davis.

THE ARMSTRONG RAPID-FIRE GUN.

(From *Industries*.)

THE accompanying illustrations show one of the rapid-fire guns shown at the Naval Exhibition by the Elswick Works of Sir W. G. Armstrong, Mitchell & Company. The gun illustrated is of 4.7-in. (12 cm.) caliber. Fig. 1 is a general view of the gun as mounted; fig. 2 is an elevation; fig. 3 a section; fig. 4 an end-view, and fig. 5 a section on a larger scale, showing the breech mechanism.

These guns, which are the latest product of the Elswick Works, differ from the Nordenfeldt, the Gatling, and other machine guns, in being loaded by hand, in having only one barrel, and generally in being larger in size. The quick-firing or rapid-fire gun differs from an ordinary gun by having special breech mechanism, and particularly by the use of cartridge cases, which are generally made of brass or gun-metal, composed of two or more pieces screwed or riveted together, or solid-drawn out of one piece. One of these cartridge cases constructed in the latter manner, which has been fired twenty times in a 4.7-in. quick-firing gun, is exhibited to show how successfully they are constructed. After each time of firing these cartridge cases are re-formed, for which purpose special tools are provided.

The first quick-firing guns were made to fire 3-lb. and 6-lb. projectiles at the rate of 20 to 30 per minute under favorable conditions. Since then guns of this type have been constructed to discharge projectiles of 10 lbs., 12 lbs., 25 lbs., 30 lbs., 45 lbs., 70 lbs., and 100 lbs. The 12-cm. (4.7-in.) quick-firing gun has, however, been so far the most largely adopted of the larger sizes. Originally introduced as a 30-pounder, it was submitted to the Admiralty (in 1886), and most exhaustively tried at Portsmouth. These trials resulted in some slight modifications to the gun, which was finally adopted by the Navy as a 45-pounder. Ever since the Elswick Company have found it difficult to manufacture this weapon with sufficient rapidity to cope with the demand, and there still appears every probability of the quick-firing type being more extensively adopted. Interesting trials have been carried out by the Admiralty, in order to compare the rates of firing of the new 4.7-in. quick-firing gun and the 5-in. breech-loading service gun. Both these weapons were mounted in gunboats, and fired under precisely similar conditions, the result being that the 4.7-in. gun fired 10 rounds in 47 seconds, and the 5-in. gun took 5 minutes 7 seconds to fire an equal number. Evidently it is only a question of time and money for the complete superseding of the ordinary service gun by the rapid firer. Besides having the advantage of firing six times as often, the latter has the further advantage that between each discharge but a slight alteration in aim is required.

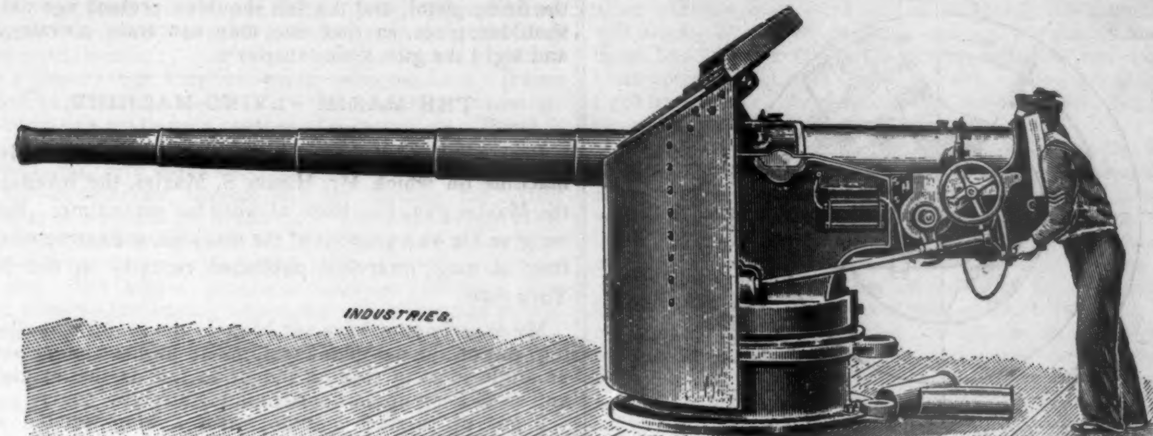
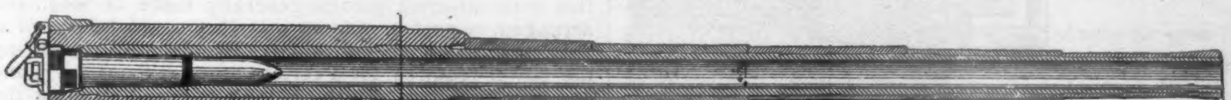


Fig. 1.

THE ARMSTRONG RAPID-FIRE GUN.

Noteworthy among many improvements, introduced to insure rapid loading and firing, is the Elswick breech screw. It is on the principle of the interrupted screw, but is made of a coned instead of a cylindrical shape. This arrangement secures two advantages, first, the action of opening and closing the breech is much simplified, as the breech screw need not be withdrawn before hinging away; and, second, the coned shape of the breech screw enables it to take hold, not only of the inner surface of the metal of the breech hoop or jacket, but also distributes the engagement, and, therefore, the strain and support, over a much larger surface. The breech-screw is further arranged so that the threads of the smaller end of the cone correspond longitudinally with the interrupted spaces of the larger end, and *vice versâ*, so that the strain and support are also distributed throughout the entire circumference of the breech-screw, instead of, as formerly,

Fig. 3



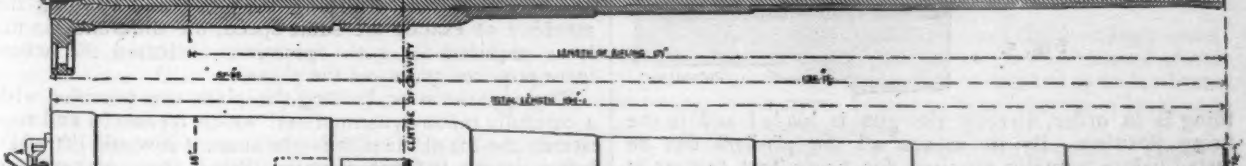


Fig. 2.

half the circumference being lost by the interrupted spaces.

Electricity is used as the means of firing these guns with advantage, as electric primers can be kept in the loaded cartridge cases without the slightest danger. An explosion would be so serious that percussion primers would never be tolerated in the cartridge cases, except just before firing, however unlikely accidental explosion might be considered. Further, the use of electricity

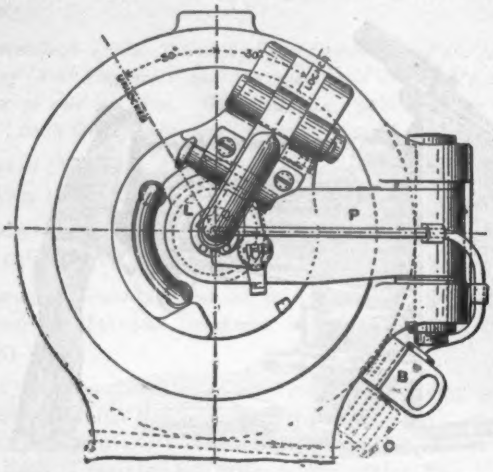


Fig. 4.

facilitates arrangements to secure the guns being in proper firing position when fired—especially necessary, seeing that the rapidity of firing is very liable to lead the gunners to omit some of the routine of their work. To obviate failure, the electric light is always supplied in duplicate, and sometimes even a third current is provided, and percussion firing can also as a last resort be substituted with barely a moment's pause.

An ingenious electric sounder has been devised to assist in providing against miss-fires, and can be seen in action in the Exhibition. It commences to ring, if every-

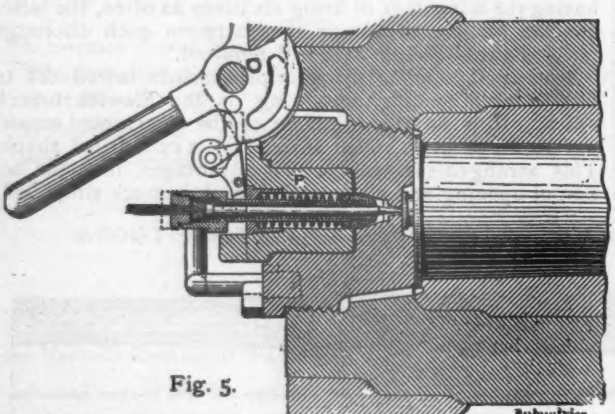


Fig. 5.

thing is in order, directly the gun is loaded and in the firing position. By its means all the primers can be tested before actually required for firing, and further it has the merit of being free from complication. Considerable attention has naturally been given to providing a suitable mounting for these guns. Instead of being fitted with trunnions they are placed in cradles, keys being provided on the guns, which, working in keyways in the cradle, prevent the gun from turning. The breech of the gun is fitted with a horn, which is connected with a piston-rod working in the recoil press cylinder under the cradle. Two steel rods are also attached to the horn on the gun, and, passing each side of the recoil cylinder, are connected with a spiral spring which causes the gun to return to the firing position after absorbing the recoil energy. On the cradle are trunnions which fit into bearings in the sides of the carriage. The latter are cast steel, and are bolted to the upper roller path and to the 3-in. vertical shield which forms the front part of the mounting. The upper roller path is stamped into form by hydraulic pressure. It runs on 24 rollers, provided with flanges on the interior edges, and kept in place by a circular ring, each roller working on to an axis bolted on to the ring. Thus the resistance offered by friction is minimized, and the training of the gun we illustrate can be effected with ease by a push, although gearing is provided. Elevation is obtained by a hand-wheel geared into the elevating arc fitted to the cradle, placed so that it can be used with the left hand while the eye is on the sights, the right hand on the firing pistol, and the left shoulder pressed against the shoulder piece, so that one man can train, elevate, fire, and sight the gun simultaneously.

THE MAXIM FLYING MACHINE.

REFERENCE has been made heretofore to the flying machine on which Mr. Hiram S. Maxim, the inventor of the Maxim gun, has been at work for some time. Below we give his own account of the machine, the extracts being from a long interview published recently in the New York *Sun*.

My experiments have not been in the realm of ballooning, but on the aeroplane system—to propel a plane set at an angle so as to ride on the air as fast as the air yields, and so to keep up an approximately straight course.

I put up a steel column, with a long wooden arm arranged to rotate on top of the column; an arm pivoted to the column, simply to swing around and long enough to describe a circle exactly 200 ft. in circumference. This arm was stayed in every direction so as to be perfectly stiff, and it was as sharp as a knife, so as to offer very little resistance to the air. To the end of this arm I attached what might be called a small flying machine, arranged in such a manner that power could be transmitted to the machine through the post and arm.

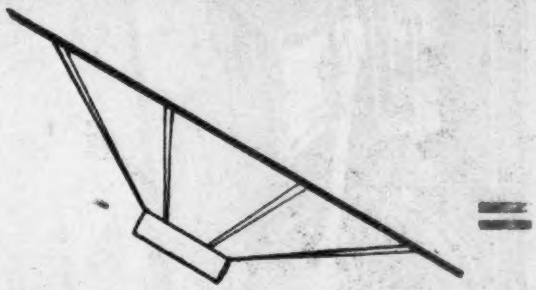
The machine had a steel shaft that could be rotated at any speed, and was also provided with a dynamometer, an instrument for measuring force. To this shaft of the flying machine were attached various kinds of propeller screws—one at a time—which I caused to be rotated at various speeds. The apparatus when complete was arranged to correctly indicate the number of turns per minute, the actual push or propelling force of the screw and the slip of the screw. When the arm was allowed to go free and the screw was rotated at a high speed, the flying machine would travel around the circle at from 30 to 90 miles an hour.

The machine was also provided with a system of levers similar to those used in ordinary druggist's scales, and to this were attached planes, generally made of wood and arranged in such a manner that they could be placed at any angle above the horizontal. By carefully measuring the power required for a certain speed without any plane attached, and then attaching the plane and running the machine at exactly the same speed, the difference in the force required for both operations indicated the actual force required to propel the plane.

The apparatus for holding the plane was provided with a carefully made dynamometer, which measured and registered the lift of the plane—the amount it would lift when being driven through the air. When these planes were perfectly horizontal and the machine was allowed to travel at a high velocity nothing was registered, but if the front or advancing edge of the plane was raised slightly above the horizontal—say 1 in 30—then it was found to have a tendency to rise. On one occasion, when a plane was placed at an angle of 1 in 25, it was found that it would carry 250 lbs. to the H.P., but this result was only obtained on one occasion. The angle was so slight and the speed was so high that it was difficult to arrive at the same result the second time on account of the trembling of the plane in the air. The angle was accordingly changed, and nearly all subsequent experiments were tried with the plane placed at an angle of 1 in 14—that is, that when the plane advanced 14 ft. it pressed the air down 1 ft.

In these experiments it was found that with every pound of push given by the screw 14 lbs. could be carried by

the plane. The skin friction on the screw and on the plane was so small as to be unappreciable; it was nothing like the friction of a screw in the water. With the angle of 1 in 14 everything ran smoothly, and experiments were tried with all speeds between 20 miles and 90 miles an hour. These experiments proved that certainly as much as 133 lbs. could be carried with the expense of 1 H.P. These are the data I personally obtained, and which I know to be true. They do not depend on theory at all. The small planes experimented with were from 2 ft. to 13 ft. long and from 6 in. to 4 ft. wide. Fifty different forms of screws or screw propellers were used in conducting these experiments. . . . . . My large apparatus is provided with a plane 110 ft. long and 40 ft. wide, made of a frame of steel tubes covered with silk. Other smaller planes attached to this make up a surface of 5,500 sq. ft. There is one great central plane, and to this are hinged various other planes, very much smaller, which are used for keeping the equilibrium correct and for keeping the flying machine at a fixed angle in the air. The whole apparatus, including the steering gear, is 145 ft. long. The machine is provided with two compound engines, each weighing 300 lbs. The steam generator weighs 350 lbs. The other things—the casing about the generator, the pump, the steam pipes, the burner, the propellers, and the shafting—all weigh 1,800 lbs. Everything is remarkably light, so remarkably light that one grate-bar in a boiler that generates as much steam as mine would weigh more than my



whole boiler. It is made of copper and steel brazed with silver solder. There are 48,000 brazed joints in the generator, and it is heated by 45,000 gas gets, there being 40 ft. of grate surface. The heat thus produced is perfectly terrific. The boiler was tested up to 900 lbs. pressure, and it didn't leak a drop.

The most novel feature about the engine is the system by which I burn petroleum and generate steam. Petroleum is turned into gas, and then that is burned for generating steam. The engines have lately been tried, and it was found that they gave a push of 1,000 lbs. on the machine, which seems to indicate that the machine will carry 14,000 lbs. The actual amount of power shown in useful effect upon the machine itself was 120 H.P. A part of the Aeroplane, or actual kite, is made of very thin metal, and serves as a very efficient condenser for the steam.

It looks much like a kite . . . . indeed, that is what it is—a huge kite, with the machinery hanging beneath it from its under side. If it were in the air, in flight, you would see a great sheet of silk and a little platform under it, between it and the earth.

The machine has not been tried, owing to my absence from England. It is ready and awaiting my return. It is now resting on a track 12 ft. wide and half a mile long, in my park. The first quarter of a mile of the track is double—that is to say, the upper track is 3 in. above the lower. By that means I am able to observe and measure the lift of the machine when it starts, because the upper track will hold it down when it lifts off the lower one. When completed the machine will weigh, with water tanks and fuel, somewhere between 5,000 and 6,000 lbs., and the power at my disposal will be 300 H.P. in case I wish to use it, but it is expected that about 40 H.P. will suffice after the machine has once been started, and that the consumption of fuel will be from 40 to 50 lbs. per hour. The machine is made with its present great length so as to give a man time to think; its length makes it easier to steer and to change its angle in the air. Its quantity of power is so enormously great in proportion to its weight that it will quickly get its speed. It will rise in the air like a seagull if the engine be run at full speed while the machine is held fast to the track and if it is then suddenly loosened and let go. If it were necessary, it could mount right up, spirally, around and around in a circle of a mile in circumference, in its own country.

If it proves as I have figured it, there should be room for fuel to carry it 1,000 miles; indeed, it looks as if it might carry two tons of fuel, or sufficient to propel it across the ocean. But I cannot tell about that; a trial alone will determine what unforeseen things, not calculated, will arise. It will be possible to burn 200 lbs. of fuel an hour, but I figure that 40 or 50 lbs. will produce a moderate speed, or for high speed, 100 lbs. The highest speed I got on the small machine was 90 miles an hour, but I believe this big one will go 100 miles an hour.

If it goes at all I shall be very happy, but on the basis of my figuring it ought to be able to develop between 250 and 300 H.P., and it ought to carry 9,000 lbs., or 1,400 lbs. with its own weight included. In warfare it will not need to carry so very much. Two men will be enough—two men and a little dynamite—a ton or a couple of tons.

As to wind, the winds are as apt to be favorable as unfavorable, but at a certain distance from the earth they cease to be formidable. You are always in a dead calm at a certain distance on high. Gales are narrow things; they don't disturb much space. Moreover, their strength and speed have been very much exaggerated in the popular mind. Let us suppose we are encountering a wind at 40 miles an hour—a very unusual speed—then if the machine is regulated to go 60 miles an hour, it will travel 20 miles against the wind, or 100 miles with it. . . .

As to what it will do, the whole world becomes changed if it works—the whole world will be revolutionized in a year. There will be no more iron clads, no more armor plates, no more big guns, no more fortifications, no more armies. There will be no way of guarding against what this machine will do.

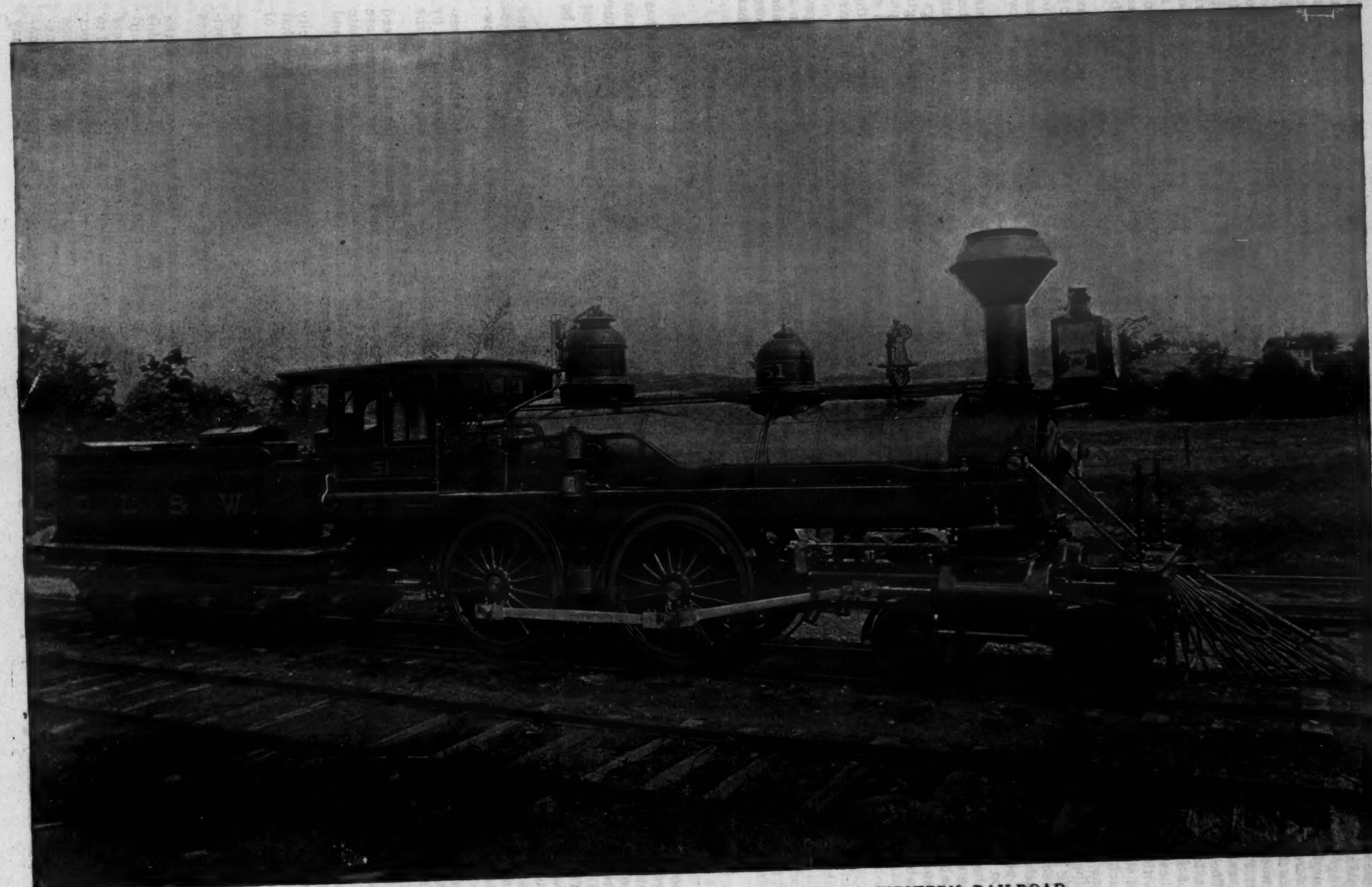
RAPID TRANSIT IN NEW YORK.

THE conclusions reached by the Commission which has been considering the question of additional rapid transit lines in New York were finally given to the public in the following resolutions adopted. These refer to the west side of the city only; plans for the east side were to be considered later.

Resolved, That after a thorough investigation, it is the sense of this Board that any additional rapid transit system for the city of New York should embrace the following essential features:

1. That it should be such as to provide not only for present needs, but also be susceptible, by additions and not by radical changes or alterations, of such expansion as the future growth of the city may require.
2. That it should provide for express trains at high speed for long distances, and for way service for intermediate distances, upon separate tracks, so located as to facilitate at proper intervals an exchange from express to local and from local to express trains.
3. That the surface of the streets and avenues in the city should be obstructed to the least possible extent, and that whenever surface ground is required private instead of public property should be used if practicable.
4. That the first lines of railroad to be constructed should be on or near the important thoroughfares coincident—or as nearly so as possible—with the main arteries of travel.

Resolved, That as meeting these requirements in the manner most feasible for the west side of the city, this Board hereby approves of a plan for an underground four-track railroad under Broadway from a point at or near South Ferry to 59th Street; thence under the Boulevard to a point at or near 169th Street, with such length of viaduct at and near Manhattan Street as may be necessary; thence under Eleventh Avenue, or under private property immediately to the west thereof, as may be found most convenient to such point as the contour of the ground may



PASSENGER LOCOMOTIVE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.
BUILT AT THE SHOPS AT KINGSLAND, N. J. W. H. LEWIS, MASTER MECHANIC.

determine; thence by viaduct across Spuyten Duyvil Creek, and by tunnel or by viaduct to the city limits.

Resolved, That the general plan of construction from, at or near South Ferry to near 42d Street shall be either by double-decked tunnel, with two tracks upon each deck or four tracks on the same level, as may be found upon examination or survey most expedient; the hole to be at such depth below the curb line as not to disturb the surface or endanger building foundations; from near 42d Street north to be four parallel tracks upon the same level; as near the surface of the street as practicable when in tunnel, but not in open cut at any point.

Resolved, That the stations for such line of railroad shall be upon property acquired for the purpose, and shall be provided with ample elevator capacity wherever the platforms shall be 20 ft. or more below the curb line.

Resolved, That the motive power for such railroad shall be electricity or some other power not requiring combustion within the tunnel.

Resolved, That the engineers of the Board be and are hereby instructed to make the necessary surveys and prepare in detail the plans and specifications for such railway, and submit the same promptly to this Board for its further action in finally determining a general plan for submission to the Common Council in accordance with the provisions of the Rapid Transit act of January 31, 1891.

A NEW EXPRESS LOCOMOTIVE.

THE accompanying illustration is from a photograph of a new passenger locomotive recently completed at the shops of the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad at Kingsland, N. J. The engine was built from the designs of Mr. W. H. Lewis, Master Mechanic of the Division, and under his supervision.

The work done by the passenger engines on this road is excellent, and not by any means easy. On the through or express trains they must keep up a high speed over a line having numerous curves and some very steep grades, while on the local trains they have to haul frequently 8 and 10 cars, with stops at intervals of one or two miles.

The engine shown is of the eight-wheel type, and burns anthracite coal. It is now regularly at work in express service.

The boiler is of steel throughout, and is 54 in. in diameter at the smallest course. The barrel, outside fire-box and back sheets are $\frac{7}{16}$ in. thick; the smoke-box and smoke-box tube-plate are ½ in. There are 200 tubes, 2 in. diameter and 11 ft. 5⅝ in. long. The fire-box is 10 ft. long and 42 in. wide inside; the side, back and front sheets are $\frac{5}{16}$ in. thick, the crown-sheet ⅝ in. and the tube-sheet ½ in. The grate area is 35 sq. ft. The heating surface is: Fire-box, 137 sq. ft.; tubes, 1,200 sq. ft.; total, 1,337 sq. ft. It will be seen that Mr. Lewis does not use the extended smoke-box.

The driving-wheels are 69 in. outside diameter, the centers being 62 in. and the tires 3½ in. thick. The driving-axles are of steel and have journals 8 in. in diameter and 9½ in. long. The driving boxes have hangers for underhung springs. The truck wheels are 33 in. in diameter. The drivers are 8 ft. apart between centers, and the total wheel-base of the engine is 22 ft. 4½ in.

The cylinders are 18½ in. in diameter and 24 in. stroke. The Richardson-Allen valve is used. The guides are of the Dean pattern, as shown by the engraving.

The engine has the Westinghouse improved automatic driver and tender brake; it is equipped with the Rushforth feed-water heater and circulator and has two No. 9 monitor injectors. It is also provided with steam heating attachments.

The tender is carried on eight 36-in. wheels; the tank has a capacity of 3,200 gallons, and the coal box will carry four tons of coal. The weight of the tender, empty, is 32,460 lbs. The total wheel-base of engine and tender is 47 ft. 6½ in.

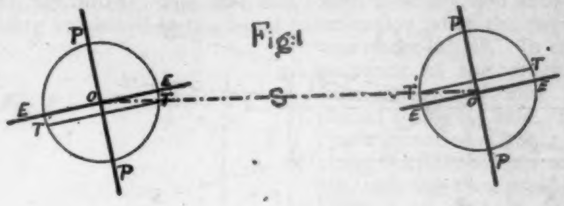
The weight of the engine in working order is 106,000 lbs., of which 74,455 lbs. are carried on the driving-wheels, and 31,545 lbs. on the truck.

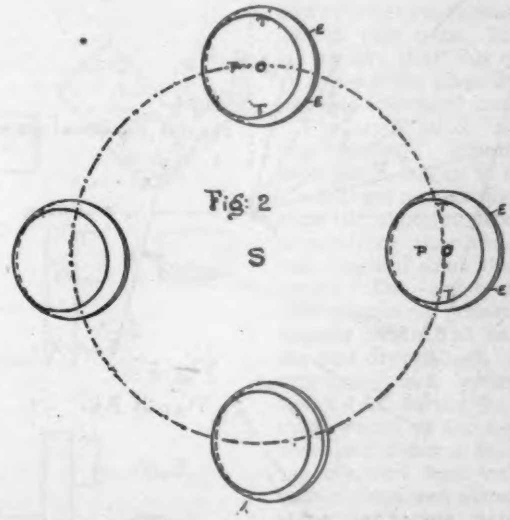
SUNDIALS FOR LOW LATITUDES.

By George L. Cumine, C.E.

THE design of a dial for any given latitude must be based on a knowledge of the relative positions of the sun and the earth throughout the year; that knowledge possessed, designing a dial is a process of simple projection, like the preparation of an ordinary working drawing in elevation and plan; and the accuracy of the more important dimensions can be checked by means of equally simple processes in plane trigonometry.

Figs. 1 and 2 are respectively an elevation and plan of the plane in which the earth makes its annual circuit (in the figures *proportion* is necessarily disregarded); *S* represents the sun; in fig. 1 the earth appears at midwinter and midsummer, when the axis *P P*—about which it makes its daily revolution—lies in a plane bisecting the sun





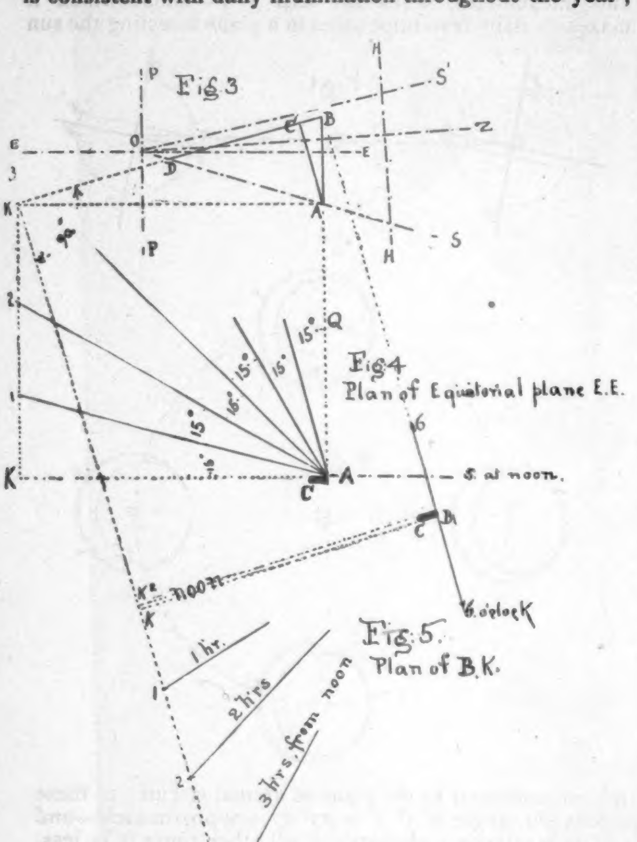
and perpendicular to the plane of annual circuit; at these periods the angle $E\ O\ T = 23° 27'$—approximately—and is at its maximum; obviously at all other times it is less, and in the two other positions shown in fig. 2 it becomes zero, the equatorial plane *E E* coinciding with the line *S O*.

The two circles *T, T'*, each in latitude 23° 27', limit the tropics within which all parts of the earth's surface are in turn subjected to vertical rays from the sun; thus in fig. 1 the sun's rays strike vertically on one limit of the tropics in the left-hand view of earth, and on the other limit in the right-hand view.

An ordinary sundial consists of a triangular plate—called the "style" or "gnomon"—set in a vertical plane, with its upper edge parallel to the earth's axis, and a plane face, to which the style is rigidly attached, so graduated that the shadows successively cast by the upper edge of the style on the graduations indicate solar time. The corrections by which "solar time" may be reduced to "mean time," or that in every-day use, are to be found in almost every almanac, frequently appearing under the headings "sun slow" and "sun fast." On the angle made by the dial face with the horizon, and the relative sizes of the style and face, depends the suitability of the dial to its position, while the truth of its indications is a result not only of precisely correct construction and graduation, but of correct setting of the whole dial in position.

Suppose a dial to be required for latitude 5° N. In fig. 3, as before, *P P* represents the earth's axis and *E E* the

equatorial plane ; $O\ Z$ is the vertical passing through the point at which the dial is to be set, and making an angle with $E\ E$ of 5°. $H\ H$ perpendicular to $O\ Z$ is the horizontal. Draw $A\ B$ parallel to $P\ P$ to represent the upper edge of the style. Draw $O\ S$, $O\ S'$, making the angles $E\ O\ S$, $E\ O\ S'$ each equal to 23° 27', so that $S'\ S$ represents the extreme northern and southern positions of the sun ; plainly, a dial face set so near the vertical as to stand inside the angle $S\ O\ S'$ will, during a part of the year, have the sun on its back, its face in shadow and consequently be for a time useless. Again, a little consideration will show that a horizontal dial face will be so nearly parallel to the style-edge that the style will be diminutive, casting disproportionately small shadows for three hours each way from noon. Therefore, draw $B\ D$, making an angle of 24° with $E\ E$, to represent a dial face as nearly vertical as is consistent with daily illumination throughout the year ;



the length of the face, $B\ D$, should be at least such that $S\ O$ cuts D, when A lies in $S\ O$, as in the figure. Now erase all lines and marks but $D\ B$, $B\ A$, and retaining the relative proportions and positions of these, produce them to fit a good working scale, say full, or, for a large dial, half-size. Draw $A\ C$ perpendicular (this is customary and convenient, but not necessary) to $B\ D$; then $A\ C\ B$ is the style. Now project the inverted view, fig. 4, and produce one side of $A\ C$ to K, projected from where, in fig. 3, $A\ K$ perpendicular to $A\ B$ intersects $B\ D$ produced. Divide the quadrant $K\ A\ Q$, fig. 4, into six equal angles of 15° each, the dividing lines being extended to cut $K\ K$ at 1, 2, 3, 4, 5 ; notice that these lines represent hourly shadows, as the earth makes one quarter-revolution. Now project —again from fig. 3—the plan shown in fig. 5 ; producing $B\ C$ to K and laying off, perpendicular to $C\ K$, the distances $K\ 1$, $K\ 2$, $K\ 3$, $K\ 4$, $K\ 5$ obtained from fig. 4 ; draw radiating lines connecting these points with B, when half the dial-face will be divided for five hours from noon. If, now, a parallel line to $B\ K$ be drawn, distant from it the thickness of the style, five hours on the other side of noon may be similarly laid off from the newly found point $K\ 2$.

Finally, a perpendicular to $B\ K$, drawn through B, will give the six o'clock lines, morning and evening. The hours may be subdivided as much as desired in a similar manner ; thus, for quarter hours, the quadrant in fig. 4 would be divided into arcs of $\frac{90°}{6 \times 4} = 3° \ 45'$ each.

Practically, for a large dial, it is best to compute the distances necessary for graduation and lay them carefully out to scale. The formulæ are, calling the style—angle $C\ B\ A$ in fig. 3—B :

$A\ K = \tan.\ B \times A\ B.$ $B\ K = \sec.\ B \times A\ B.$

$$\begin{cases} K\,1 = \tan.\ 15° \times A\ K. \\ K\,a = \tan.\ (15 \times a)° \times A\ K. \\ K\,5 = \tan.\ 75° \times A\ K. \end{cases}$$

The division lines having been laid down full size on a sheet of paper, a line parallel to and an inch or more inside of the intended edge of the dial-face may be drawn and the divisions pricked through thereon. Notice that while this sheet must be full size, the projections—still necessary for determining the arrangement and proportions of the dial—may be to any convenient scale.

In construction care must be taken to fix the style exactly perpendicular to and with its indicating edge at the proper

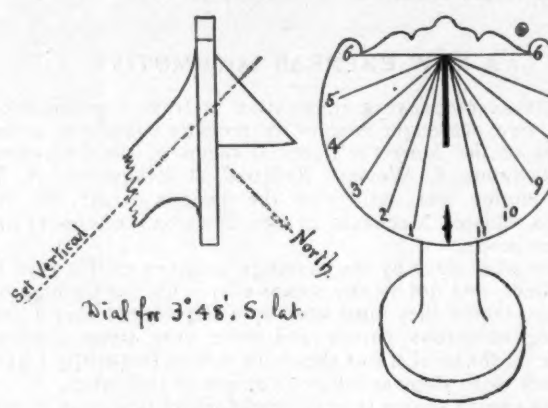


Fig. 6.

angle with the dial-face. And in setting a dial the six hours' line must be levelled, the face put at the proper angle with the horizontal, turned *southward* in *north* latitude, and *vice versa*, and the plane in which the style lies must be *truly* north and south.

The dial-face illustrated in fig. 6 is designed to make an angle of 45° with the horizon in latitude 3° 50' south ; the lessening of the hour-angles toward noon would be much more conspicuous in a horizontal dial, while it would be imperceptible in one making only 21° with the vertical, which would be the steepest pitch practicable in this case. In fig. 3 the dial-face makes an angle of 24° with $E\ E$, and consequently of 19° with the vertical, the latitude being 5°.

Within the tropics the minimum admissible angle for a dial-face to make with the vertical is 23° 27' minus the latitude.

Adaptations of figs. 3, 4 and 5 will serve to ascertain the best arrangement of dial for any latitude. It must be understood that the account given above of the motion and inclination of the earth, although correct, is not precise ; as a matter of fact the obliquity of the ecliptic, given above as 23° 27', is continually changing, its present rate of annual diminution being rather less than half a second.

Wooden sundials are liable to warp ; stone and metal ones require special appliances not always available for their manufacture. Where cement can be had excellent dials can be moulded, care being required, however, not to use a dry wood mould, otherwise it will absorb the water from the cement, becoming warped itself and leaving the cement with a crumbling surface. The mould, if of timber, should be thoroughly soaked before being filled, and then, if Portland cement is used, re-immersed in water, as the cement sets best when kept wet. A graceful and lasting monolith can be produced in this manner.

EXPERIMENTS WITH A STEEL CRANK-SHAFT.

(Paper by H. A. Ivatt, before the Institute of Civil Engineers of Ireland; published in the *Practical Engineer.*)

ALMOST all failures of steel axles begin with a crack, and it is well known that a crack once started in a steel axle will continue to extend—if the axle be kept at work—until it finally goes right through; that is, until the axle breaks; and interesting questions arise as to the original cause of the crack or flaw, as to the method or frequency of examination; also, perhaps, the question may arise as to whether a given crack is sufficient to condemn an axle. Various methods of strengthening axles have been proposed, the one most generally adopted being that known as hooping, which, as the term implies, is done by shrinking wrought-iron hoops over each of the sweeps or throws of the crank. The author believes that there would be practically no limit to the life of a steel crank axle, of proper dimensions, if it could be kept from developing a crack.

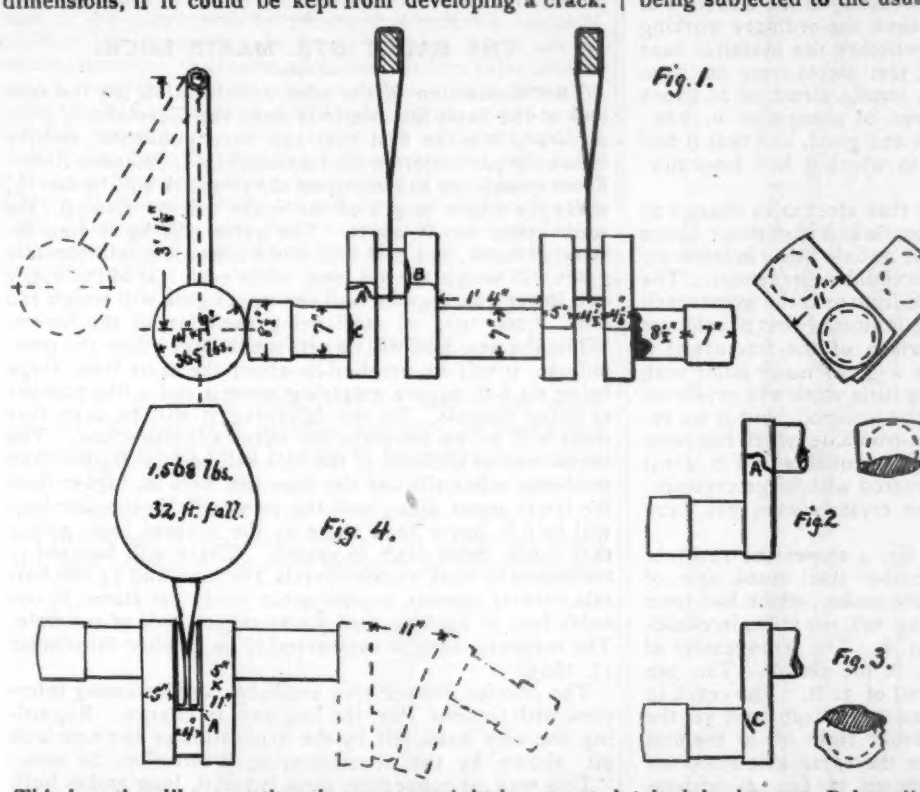


Fig. 1. Fig. 4. Fig. 2. Fig. 3.

This is rather like asserting that a man might be expected to live a very long time if he never contracted any disease. But what is meant is that the weak point about steel crank axles is their liability to start a crack, and a crack once started is practically impossible to stop; if any method could be devised whereby the starting of a crack could be prevented, then the life of the axle would be indefinitely prolonged. There is no doubt that if the crack could be seen directly it commenced, and could be at once cut out, the axle—although weakened in sectional area by the cutting out—would last much longer than it would have done if the crack had been allowed to go on. Steel being homogeneous, there is nothing in the formation of the material to arrest a crack, but the crack goes on just as it does in a sheet of glass or a lamp globe. The author, believing that vibration alone would cause a crack in a steel axle to extend quite as rapidly as it would under the strains due to ordinary working, tried the following experiment: A steel crank axle, which had been withdrawn from service on account of a crack—more fully described below—was suspended by sling-chains round the crank-pin bearings, and in this position was subjected to blows on the end from a hanging weight, as shown in fig. 1. The weight was 365 lbs., and was hung on a lever about 3 ft. long. The lever was drawn back and let go by means of a cam, worked from the shop shafting, and gave a blow on the end of the crank axle of about 182 foot-pounds. The chains in which the axle hung were about 2 ft. 6 in. long, and the axle weighed 2,016 lbs. The blows averaged about 3.6 per minute, the effect being to keep the axle in a state of vibration, and the end of the axle finally dropped off where marked *B* after 645,300 blows had been delivered. The axle used in this experiment was forged by Messrs. Vickers, of their best steel, and finished at Inchicore. The following are its leading dimensions:

Diameter at wheel seats	8 ½ in.
Diameter of bearings	7 in.
Diameter of crank-pin bearings	7 in.
Thickness of outside webs	4 ⅜ in.
Thickness of inside webs	5 in.
Diameter of axle between cranks	7 in.
Length of stroke	24 in.

It was at work under a six-wheeled coupled yard engine, having wheels of 4 ft. 6 in. diameter and had run some 176,327 miles. The axle was found to be cracked at *A* on being subjected to the usual examination when the engine was under repair. In consequence of the crack it was condemned and replaced by a new axle. The crack extended about 4 in. along the fillet of the crank-pin, and was then probably about ⅛ in. or ⅙ in. deep, and no other crack was visible at that time. It will be noticed that this crack at *A* is not the place where the axle afterward broke.

The crack at *B*, where the breakage eventually took place, began to show about three or four months after the experiment commenced, or after the axle had received some 180,000 blows. The crack at *C* was discovered about two months before the end of the axle dropped off. The original crack extended about ⅝ in. during the first three weeks of the experiment and about ⅛ in. during the next four weeks; it then remained about the same for some months, and the principal action then seemed to go on in crack *B*. After the axle had broken at *B* by vibration, it was forcibly broken through cracks *A* and *C*, and the shaded parts on figs. 2 and 3 show the extent to which these cracks had grown. The state of vibration into which the axle was thrown by the blows on the end was evidently more trying, at any rate in the direction of developing cracks, than the strains to which it was subjected when at work. The axle was suspended, and the blow was not sufficiently severe to cause any undue strain; probably the actual strain on the material in the neighborhood of the cracks caused by the blow itself (apart from the resulting vibration) was very far short of the strain to which it would have been subjected at every revolution if it had been at work under the engine. When at work the axle carried a load of about six tons on each bearing, and had to transmit the work done by a pair of 18-in. cylinders, with a steam pressure of 140 lbs. It had also to withstand the pinching action which takes place between the rails and flanges, particularly on curves, and which action is specially severe on a crank axle; and yet the author believes that if this axle had been allowed to continue at work it would not have broken in so short a time as it did under the treatment it received in the experiment.

The axle—as mentioned above—broke after 645,300 blows, which took 2,673 hours to deliver—that is, the experiment lasted about one year, at the rate of ordinary

shop hours of 54 per week. If the axle had been at work, it would have run some 20,000 miles during 12 months on the kind of work at which the engine was employed, and in that time the axle would have made nearly 7,500,000 revolutions. It is believed that the effect of the vibrations resulting from each blow was much more severe on the axle than the injury it would receive from each revolution if at work. If we assume that each blow in the experiment only affected the axle to the same extent as each revolution would have affected it, then if allowed to go on working it would have broken after 645,300 more revolutions, or less than an additional 1,500 miles. It is difficult to speak with any certainty upon the subject, and it is of course impossible to test the same axle to destruction by each of two different methods, but a considerable experience in flaws developed by crank axles leads the author to believe that this particular axle would have run many more miles than 1,500 before it broke at the crack *A*, and the experiment seems to show that the effect of vibration is more trying to a steel axle—particularly in the direction of starting or extending cracks—than the ordinary working strains. In order to ascertain whether the material near the cracks was of good quality, test pieces were cut from the crank sweep; these gave a tensile strain of 24.4 tons per square inch, with 36 per cent. of elongation in 8 in., showing that the steel was soft and good, and that it had not suffered from the vibration to which it had been subjected.

The author does not believe that steel axles change or become crystallized under long-continued vibration; hence the remark above as to the life of an axle being indefinitely prolonged if the starting of cracks could be prevented. The result given by the test pieces, cut from near the worst crack in the axle experimented upon, indicates that no change had taken place; and a comparison of the fracture of a steel crank axle which has run a great many miles with that of one which has done very little work will reveal no difference in the appearance of the material; but if we examine the fracture of a wrought-iron axle which has been at work for some years, we shall probably find a great deal of the fractured surface covered with large crystals; but this does not prove that the crystals were not there when the axle was new.

Following up this subject, fig. 4 shows the result of wedging open the sweeps of another steel crank axle, of the same material and by the same makes, which had been removed from work after running 207,400 miles in consequence of a crack developing at *A*. The arrangement of wedge and tup used is shown in the sketch. The tup weighed 1,568 lbs., and had a fall of 32 ft. The crack in this case was only ¾ in. long and ⅛ in. deep, and yet the crank in which the crack was broke right off at the first blow; while the other crank on the same axle stood ten blows and opened 7 in.—as shown in fig. 4—without breaking, showing that the material was wonderfully sound and tough, and had in no way suffered by the work it had done in running 207,400 miles.

It is difficult to account for the commencement of a crack in a steel axle. No doubt, an air bubble in the ingot from which the axle was forged would account for a crack; but it is possible that cracks may start from less obvious causes than air bubbles or other defects in the original ingots. It may be that a scratch from a file or lathe tool, or from a piece of grit in the bearing, is sometimes sufficient to start a crack, in the same way that a diamond starts a crack in a sheet of glass. That this may be so seems at least possible, when we consider that, in cutting out a crack, if the smallest part of the crack be left it will gradually increase and extend; and an injury to the skin of the metal, such as is called a scratch, may, under certain conditions, be in the form of an incipient crack. In cutting glass with a diamond, the cut made when the diamond is properly held is really the crack and not a scratch; it is, in other words, a forcing apart of the material, leaving an unfinished tear, which is ready to extend right through when strained sufficiently.

The author regrets that his experiment does not do more than help to show the effect of vibration. If it had been suspected that cracks would start at *B* and *C*, in addition to the one known to exist at *A*, then a more careful examination of the surface of the metal at those places would have been made; but an experiment of the kind takes a long time to carry out, and a crank axle weighing 2,000 lbs. cannot be turned over and examined frequently without considerable trouble. If there may be any truth in the suggestion that cracks may arise from surface damage as distinct from inherent flaws, then no doubt precautions could be taken to prevent such damage, and perhaps some method of treatment analogous to burnishing the surface of the metal might be of advantage. The idea that cracks in steel shafts may start from some kinds of apparently trifling surface damage may be regarded as being rather far-fetched, and yet, on the other hand, it is borne out by the fact that cracks have been known to start from the corners of small key-seats cut in steel axles. A great deal remains to be discovered as to the exact causes of the failure of steel under different circumstances, and the above-mentioned experiment is noted as bearing upon one branch of the subject.

THE SAULT STE. MARIE LOCK.

THE illustration of the plan and location for the new lock at the Sault Ste. Marie is from the Cleveland *Marine Review*; it is the first that has been published, and the following particulars were furnished by Lieutenant Riche. From quoin-post to quoin-post the new lock will be 800 ft., while the whole length of the walls will be 1,100 ft., the walls being 100 ft. apart. The gates will be of steel instead of wood, and each leaf of the lower and intermediate gates will weigh 150 net tons, while each leaf of the upper and lower guard-gates and the upper gate will weigh 100 tons, 1,200 tons of steel being used for all the leaves. While the new lock will be very much larger than the present one, it will be emptied in about the same time, there being six 8-ft. square emptying tunnels and a like number of filling tunnels. By the following it will be seen that there will be no necessity for miter sill protection. The breast wall at the head of the lock will be 6 in. higher than the lower miter sill, and the floor will be 6 in. higher than the lower miter sills; and the miter sills in the new lock will be 6 ft. lower than those in the present lock, giving that much more draft to vessels. There will be used in the masonry work 22,000 barrels Portland and 75,000 barrels natural cement, 20,000 cubic yards cut stone, 59,000 cubic feet of backing and 5,000 cubic yards of concrete. The masonry work is contracted to be finished November 15, 1893.

The *Marine Review* also publishes an interesting interview with General Poe, the Engineer in charge. Regarding the clay bank left by the excavation of the new lock pit, shown by the accompanying illustration, he says: "This wall or connection bank is 700 ft. long and is built in the canal in prolongation westward of the north wall of the present lock. Its stability is reasonably assured, although it is a source of anxiety, because of the possibility of even a slight delay to navigation. It is capable of withstanding the water pressure, but a heavy shock from a vessel might do damage, therefore extreme care and caution is requested from navigators. The cofferdam is a necessary adjunct to the new lock, and the positive necessity of locating a portion of the dam in the canal, the character of the bottom, the impossibility of driving spiles combine to render the work one of difficulty. The bottom of excavation in the new lock is 53 ft. below level of the water in the canal and 35 ft. below level of water at the lower end of lock. The northern slope of the excavation extends to the rapids. The leaks encountered so far have had their origin in the rock formation below the constructed dam. It is improbable that there should be a worse leak than the one that occurred in March, yet this was successfully closed under most adverse circumstances in unfavorable weather, and were a leak of similar volume to occur again, it would not greatly hinder or delay navigation of the present lock. The dam is now stronger than ever and its present strength can be maintained. All that has occurred thus far and all the speculations put forth as to what circumstances might arise during the construction of the new lock were fully dis-

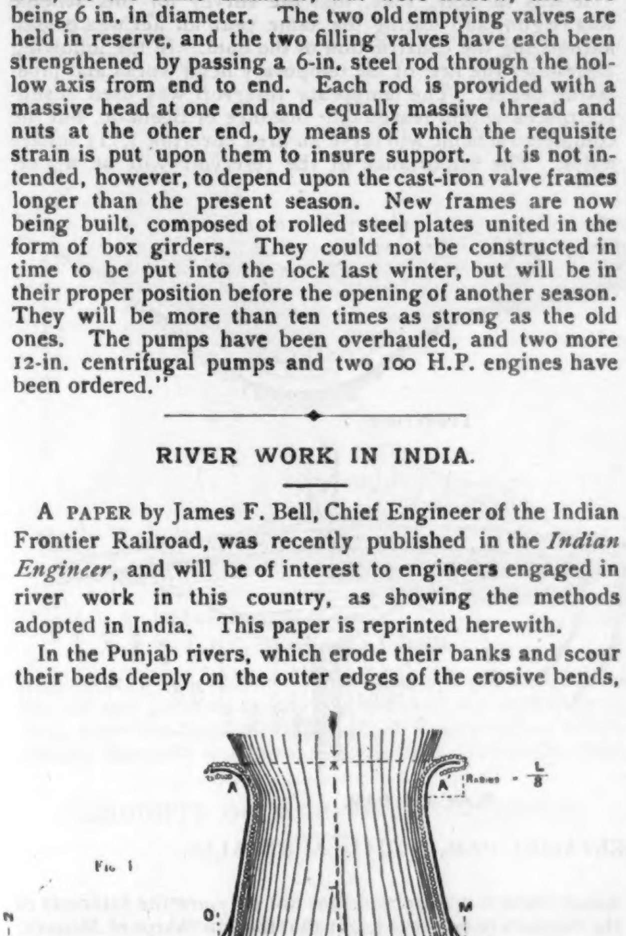
cussed in my report made in 1887. All was foreseen, and the present plan of procedure was adopted as the most safe one for interests concerned. The work cannot be stopped or retarded until winter, for the masonry work can only be prosecuted during warm weather.

"The chance of a repetition of an accident similar to the one last August has been greatly diminished by replacing the emptying valves and their frames with entirely new ones. The frames of these new valves are of cast iron, like the old ones, but strengthened wherever possible. The new valves, however, are built entirely of steel and wrought iron. The trunnions are of forged steel, tested to a tensile strain of 63,000 lbs. per square inch, 9 in. in diameter, while those of the old valves were of cast iron, of the same diameter, but were hollow, the bore being 6 in. in diameter. The two old emptying valves are held in reserve, and the two filling valves have each been strengthened by passing a 6-in. steel rod through the hollow axis from end to end. Each rod is provided with a massive head at one end and equally massive thread and nuts at the other end, by means of which the requisite strain is put upon them to insure support. It is not intended, however, to depend upon the cast-iron valve frames longer than the present season. New frames are now being built, composed of rolled steel plates united in the form of box girders. They could not be constructed in time to be put into the lock last winter, but will be in their proper position before the opening of another season. They will be more than ten times as strong as the old ones. The pumps have been overhauled, and two more 12-in. centrifugal pumps and two 100 H.P. engines have been ordered."

RIVER WORK IN INDIA.

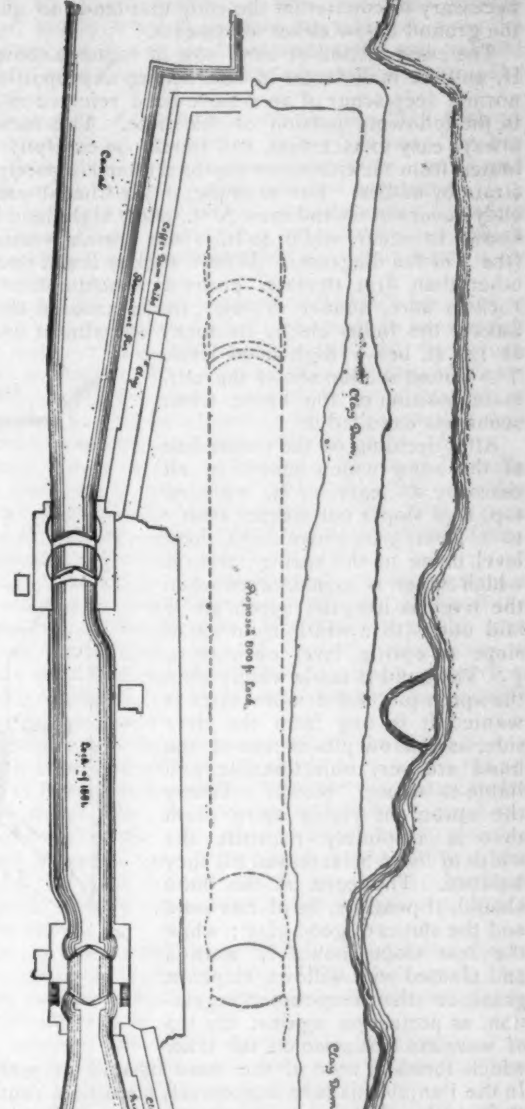
A PAPER by James F. Bell, Chief Engineer of the Indian Frontier Railroad, was recently published in the *Indian Engineer*, and will be of interest to engineers engaged in river work in this country, as showing the methods adopted in India. This paper is reprinted herewith.

In the Punjab rivers, which erode their banks and scour their beds deeply on the outer edges of the erosive bends,



our practice is to retain the stream within a limited length of the bridge by protective *bunds*, faced and aproned with rough stone pitching. In cases where there is no solid ground on which the heads of these flank bunds can rest, we make their length up-stream at least equal to the length of the bridge itself, and extend both of them down stream beyond the abutments to a distance of at least one-fourth the bridge length.

The alignment that is thought best on abstract considerations is sketched in fig. I. In the absence of natural heads those at *A A* are strengthened by very large mounds of stone, in cases as much as 300,000 cub. ft. per



THE OLD AND THE NEW LOCKS, SAULT STE. MARIE CANAL.

head. The extent to which the river should be throated between *A* and *A* depends on the number of piers in the bridge, as these so obstruct and subdivide the channel that a very much narrower width at *A A* gives a much larger effective channel than that afforded by the bridge. The object of the *vena contracta* on plan is to center the

river, and make it fan out equally in all the spans. As a rule the conditions of the site do not admit of using the *vena contracta* ground plan, and it is found that where the bunds diverge on the up-stream side there is a proportionate tendency for an island to form in the middle of the bridge which splits the deep channel toward the abutments. The down-stream tails of the bunds at *B B* are necessary to counteract the eddy that tends to undermine the ground below either abutments.

The cross-section of bund now in vogue is shown in fig. II, and the main factor in determining its proportions is the normal deep scour of an erosive bend referred to as "*S*" in the following portion of this note. This factor is not always easy to ascertain, and should be carefully discriminated from the enormous depths attained in purely alluvial strata by eddies. For example, in the Chenab and Sutlej, eddy-scours of 60 and even 70 ft. below high flood level are known to occur, while 40 ft. is the normal erosive scour (the *S* of the diagram). Where rock is found overlaid by other than firm strata of probably considerable age, the rock is sure, sooner or later, to be scoured clean. At Sukkur the Indus cleans its rocky bed almost every year at 120 ft. below high flood level. The dotted section shows the ultimate position of the apron when scour has engulfed it.

After deciding on the center line of the bund (which should in all cases be at least 20 ft. wide on top, with slopes not steeper than 2 to 1 from 3 ft. above high flood level down to the spring level, at which water is encountered when the river is low) the apron pit is laid out with a width from toe of slope at spring level outward = $\frac{3}{2}$ *S*. The bund is made wholly from the apron pit, and if more earth is wanted it is dug from the river side, as borrow pits in rear of the bund are very objectionable, and liable to induce "blows." Where the apron pit yields more earth than is absolutely requisite the width of bund is increased till they balance. The core of the bund should, if possible, be of fine sand and the slopes of good clay; while the rear slope should be wattled and planted with willows, elephant grass, or other deep-rooted vegetation, as protection against the lap of wavelets that arise on the lake, which forms in rear of the bund by spill or percolation. In the Punjab this lake is purposely filled by a controllable sluice inlet that brings in silt to warp up the lake bed. This process is only effective when a high level outfall draws off the clean upper water and keeps up a steady influx of silt during flood time.

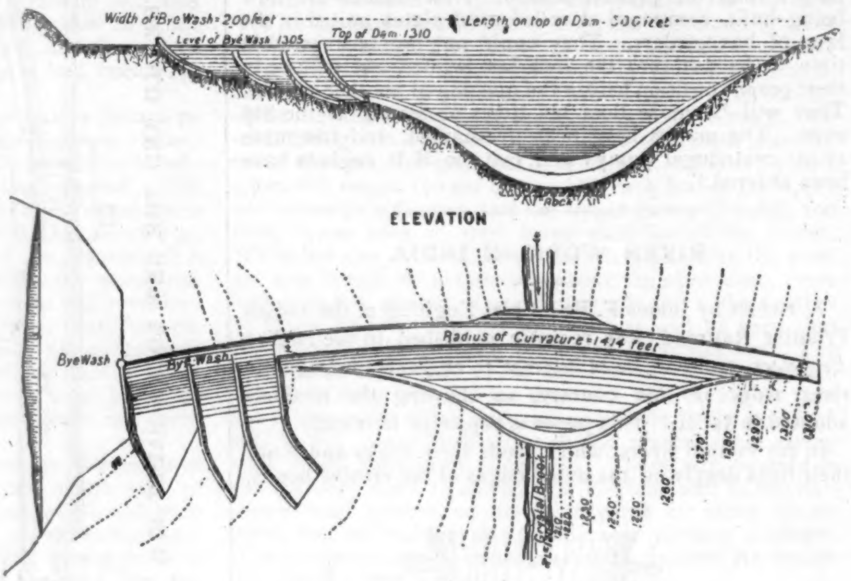
We now invariably lay the apron 4 ft. thick, and hence its cross sectional area = $S \times 5$. The total amount of stone laid in at first = $S \times 8$ and the surplus or reserve = $S \times 3$ is stacked on the river slope of the bund at as steep an angle as it will stand, usually a little steeper than 1 to 1. The top of the bund carries a tramway by which the reserve can be transferred to any point where heavy scour threatens to engulf the reserve stone already in place. During the first three or four years of its existence we think it essential to renew the entire reserve when the river is low, and even to increase it when the indications point to our having underestimated the factor *S*.

Sharp-edged stone is best; and round or even cubical pieces are found wasteful and inefficient. The individual pieces should be of approximately one size, and their weight ought to be the greater as the velocity of the stream increases. For 6 ft. per second average velocity, stones averaging 110 lbs. suffice, if sharp-edged and of high specific gravity, to revet a subaqueous slope as far down as the scour extends. We attribute the success in point of stability and economy that has so far invariably attended this method, as compared with that of stone-faced spurs, to the fact that the latter provoke and intensify *eddy-scours*, while the former tends to eliminate eddies and to straighten out and so minimize the attacks of *bend-scours*.

A GREAT AUSTRALIAN DAM.

THE accompanying illustrations, from the London *Engineer*, show a reservoir and dam just completed at Beetaloo, in South Australia, for the Government of that colony, by Mr. A. B. Moncrieff, C.E. It is intended to store water for irrigation purposes.

It was in May, 1885, that the survey for this scheme was begun, and during the same year an act was passed authorizing the construction of the dam. In the following December the first of the temporary head works and pipe-laying began. The temporary reservoir was used to supply places within reasonable distance of Beetaloo, but the completed scheme will serve an area covering 1,715 square miles. The importance of the reservoir will be understood when it is observed that not only are the interests of the farmers to be served, but that the townships of Moonta, Kadina, Wallaroo, Tickera, Alford, Port Broughton, Gladstone, Port Pirie, and other places will be supplied from Beetaloo. Up to the present time 255 miles of main pipes have been laid, the sizes varying from 18 in. to 2 in. in diameter. The pipes were all locally manufactured, and the Engineer-in-Chief speaks of them as highly creditable samples.



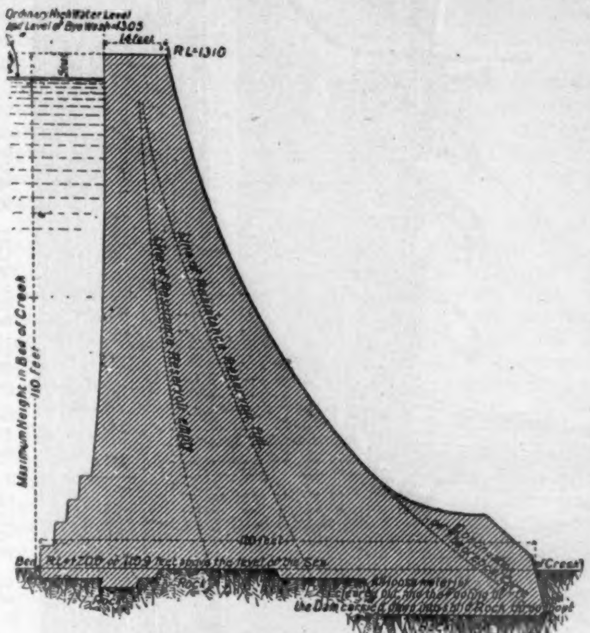
THE BEETALOO DAM, SOUTH AUSTRALIA.

The main interest centers in the concrete dam, which ranks as one of the largest dams in the world, and is certainly the largest concrete dam in the Southern Hemisphere. This work was started by Mr. Mestayer, the late hydraulic engineer, in 1888, and Mr. Jobson has been the Resident Engineer. In May of the same year the present Engineer-in-Chief, Mr. A. B. Moncrieff, took the work in hand, and as soon as the diagrams and stresses were checked by him the placing of the concrete was proceeded with. This continued with few intermissions until last October, so that the laying of the concrete occupied two years and six months.

About 60,000 cubic yards of cement concrete were required. The height of the weir is 110 ft., and the width on the top is 14 ft. The length is 580 ft., and the cross-section is in accordance with Professor Rankine's formula, the horizontal curvature having a radius of 1,414 ft. The stone and sand required were obtained in the neighbor-

hood, but the cement had to be imported from Europe. Machinery was employed to mix and deposit the whole of the concrete. To the western side of the dam there is a bywash, with massive training walls, which are partly excavated in the rock on the hillside. When the reservoir is full and the water flows over this bywash, there will be a pretty cascade down the hillside.

At present the reservoir is only half full, but the supply is constantly being augmented by the springs, which are running strongly. When full, the lake will be 105 ft. deep at the dam, about a mile and a quarter long, and on the average eight chains wide. In places the width is much greater, as there are several long reaches, but the average



CROSS SECTION OF DAM

THE BEETALOO DAM.

width is only eight chains. The capacity of the reservoir is 800,000,000 gallons, and on the whole of the works, up to date, there has been expended about $2,410,000, of which amount $570,000 was spent in the construction of the dam.

THOUGHTS ON MARINE ENGINEERING.

By Aloha Vivarttas.

Probably there is no trade more conservative and "set in its ways" than the old line of shipbuilding, which, from the small beginning of building vessels whose greatest dimensions did not exceed the length of a single stick of timber, has grown in the size of its product, the ships, without any corresponding growth in the size of its material, the timbers.

Hence, from the increase in the number of joinings necessary to gain the increase of size, the big ship of to-day bears no comparison with the small one of yesterday in the all-important point of strength; for it appears that the builder of wooden ships never recollects that a given ratio of increase in the linear dimensions of a vessel calls for an increase of strength equal to the cube of such ratio in the construction of the larger vessel.

Take, for example, two vessels of the same model, but one of them one-fourth longer, wider and deeper than the other, and the former needs twice the strength of the latter in all its parts; or if one be double the length, breadth and depth of the other, she will need eight times the other's strength, since she will carry eight times the other's load over the same hills and gullies, and must bear eight times the strain at every point.

Again, if one be double the length, but the same breadth and depth as the other, she needs four times the other's strength longitudinally, for she has double the weight and length on the same depth.

Only a few days ago we were called upon to admire one of the biggest wooden ships afloat—just built and, as usual, changing her shape visibly according to her weight and bearing—a ship differing in no essential from many another of ancient build, except in an increase of size and proportionate decrease of strength.

The builder of iron ships took his methods of construction, with his model or external form, from the wooden ship; and although less limited by his material, as in the size of trees, he is yet far from seeing his way to build large and, at the same time, strong vessels, or to make them handy.

It is supremely ridiculous to see an iron ship with an iron mast extending clear down to her keelson, like her wooden prototype—a method of construction, costly and useless in wood, copied by imitators, not engineers.

So also in steering, the idea of causing a ship's head to turn to the right by pushing her stern to the left, which was not without its disadvantages in a small boat, is, in large vessels, absurd.

Imagine an old farmer so stupid as to hitch his reins to his horse's crupper to steer him; if he used power enough it might work, causing collisions on the road, very much as it does in ships. The engineer will yet learn to divide the rudder, and put one half of it in the stem, one-half of it in the stern, and, by using both at once, turn the big ship in a curve of one-half the radius now required.

It is said that it is easier to divide the water laterally than to compress it vertically at any one depth. So also it is easier to divide the water laterally at the surface than to divide it laterally at some distance below, and this difference increases with the depth of the vessel.

So also if a ship of a given size and model requires a certain amount of power for a given velocity, a ship of the same model and double her displacement would take more than double the power at the same velocity, or, if of double displacement, should have a greater proportion of breadth to depth, to enable her to make the same speed with double the power.

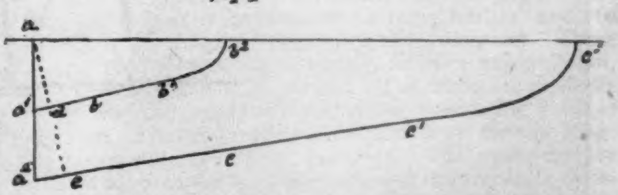
The resistance to lateral movement in the water at any one depth increases with the distance only, while the resistance to lateral movement at different depths increases with the depth also; so that while a ship of the same depth and twice the breadth of another might require twice the power at any given speed, a ship of twice the depth and the same breadth as another will require from 20 per cent. upward more than double the power to attain the same speed.

Hence the more a ship weighs the less water she should draw in proportion to her weight. Thus the diagram, fig. 1, shows two body sections, the depth of one being 5 ft. and of the other 10 ft.

It is manifest that water located on the line a, a^1, a^2 must, as either vessel passes it, move out to pass the surfaces b, b^1, b^2 and c, c^1, c^2 respectively.

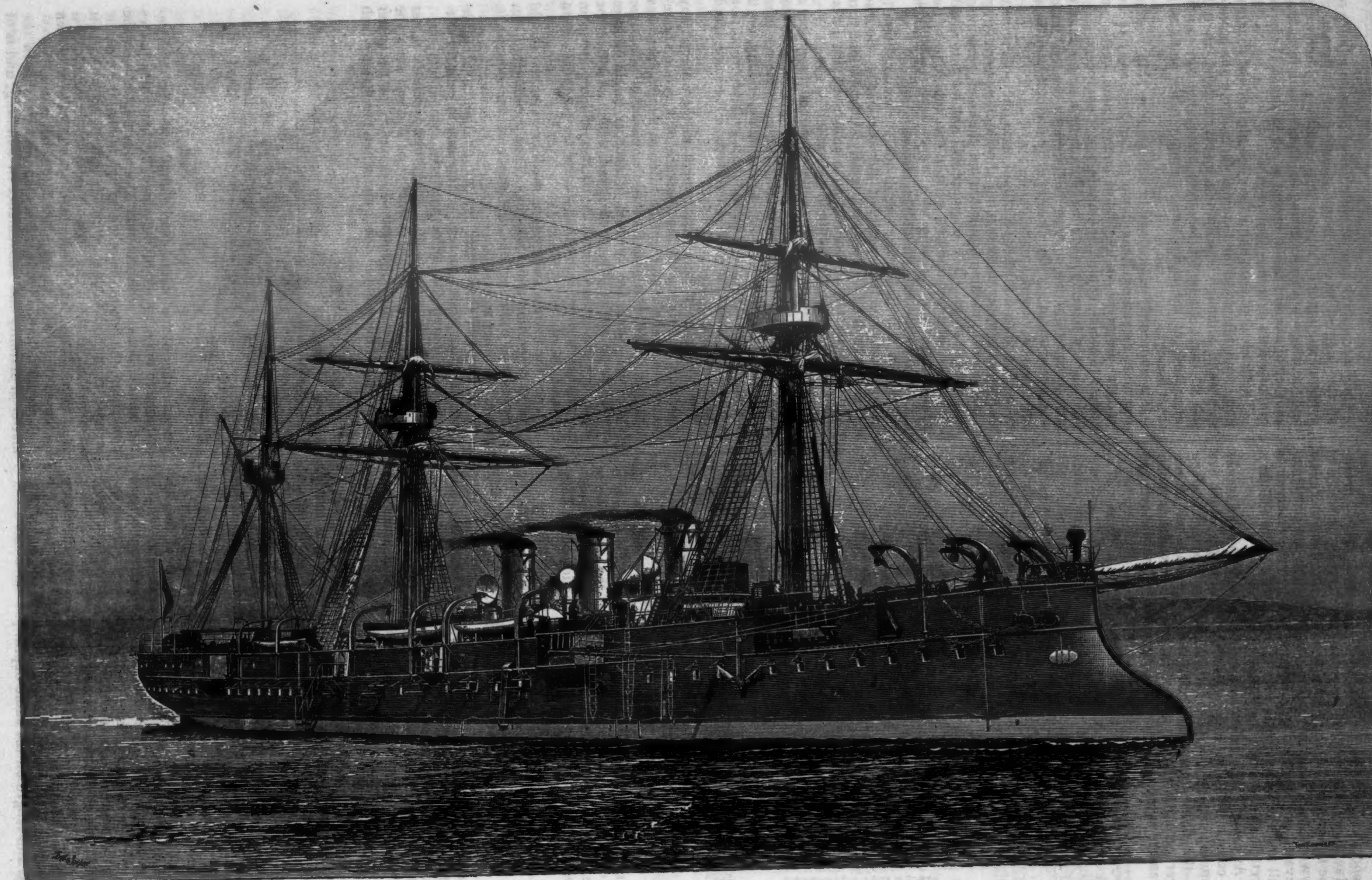
These lines show the natural proportion when the water which passes either of the points b or b^1 shall offer the same resistance to the motion of the vessel as the water which passes the point b^2 does; and when the water which

Fig 1



passes either of the points c or c^1 shall give the same resistance to the progress of the vessel as that which passes the point c^2 does. Observe that while the depths bear the proportion, the one to the other, of two to one, the beam c^2 is more than double the beam b^2; and by so much is it harder to move the water from a or a^2 to e, than from a or a^1 to d. This is in open ocean; the difference shown increases rapidly as the ship gets into shoal water.

A proper deference to this law also favors a ship in the matter of stability and convenience in handling, and is of



THE NEW FIRST-CLASS CRUISER "LE TAGE," FOR THE FRENCH NAVY.

especially great advantage when on soundings, where quick and accurate steering are called for. Had the builders of wooden ships followed up this matter and consulted the experience of their navigators, the big ships of to-day would not be simply overgrown brigs of a hundred years ago, nor the steamers of much the same proportion, and about as seaworthy as canal-boats.

The various problems involved in marine work, handled *de novo* by the class of men which has handled the bridge business in the United States during the last 50 years, would put the seagoing machine as far from the present favorites as a good pinned truss or cantilever bridge from the narrow span stone arch of former days. And even as the stone arch is, for small culverts which are not liable to freshets, very near perfection to-day, so the wooden style of boat building is, for yawls and cat-boats, very satisfactory.

It may be noted that the rules of the Underwriters do passably well for small vessels, but are less and less trustworthy as the size gets beyond that common for the time such rules have been in vogue. The man who designs for new purposes or larger sizes gets little assistance from them.

It may be questioned if the marine world, in its engineering and governing details (which are inseparable), will bear the hand of the landlubber. And no doubt the conservative element of the old "gentlemen rope-haulers" will growl, as it does to-day, at every proposed change. But looking back over the years past, which are still in sight, it is seen that all of the real marked progress in these matters is the work of men who were not trained to the sea.

Thus, without going into the controversy about who first conceived or suggested an idea, it is evident that the application of steam, the evolution of the Mississippi and the North River styles of steamboats, the New York ferry-boat (sometime driven by horses), and the fore-and-aft schooner were never brought about by the *deep sea* men.

Compare these instances of American work with the straight-bodied, double-truck car and pinned truss bridge of the same class of men, and note the same handwriting in each. Even in maritime law, R. H. Dana, not trained to the sea in the regular way, but taking a dose of it for his health only, by his "Handbook of Marine Law," which circulated in the forecastle 40 odd years ago, probably did more in the interest of law and order than all of the courts from that time to this.

The fore-and-aft schooner is more of an advance upon the old style of square-rigged vessels than the old sailormen really like to acknowledge. They can seldom handle one properly, the old rules not being all applicable, and few of them will believe that vessels so proportioned and rigged can safely go to sea when light without ballast. Yet such is a common custom of large schooners on the American coast.

The old-time mariner, handling a good sea boat, felt safe on deep water far from land, or in a landlocked harbor secure from sea. To anchor off the coast was to him a *dernier ressort*, after hope was gone. But since the blockading fleet, comprising ships, barks, schooners, steamers, and even ferry-boats, rode out the war of 1861–65, anywhere from Cape Hatteras to the Rio Grande, boldly hanging to their anchors in any weather. the coaster has taken heart of grace, and if the wind baffles him lets go his mud-hook with confidence in his ground-tackle, anywhere along the beach.

The sea calls for men who know metals, as the old ship carpenter knew wood; who know the steam-engine and all of its connections as the old boatswain knew his sails and rigging; and who can handle electricity as the old quartermaster could trim a binnacle lamp. And the master at sea must know them all, both new and old; for as the railroad has not exterminated the horse, so steam has not done away with canvas; and as the railroad engineer may easily know how to handle a "fast trotter," so the steam seaman may easily keep the run of canvas work. The engineer, in the broadest sense of the word, will find ample room at sea.

(TO BE CONCLUDED.)

A NEW FRENCH CRUISER.

THE accompanying illustration, which is taken from the London *Engineer*, shows the French cruiser *Le Tage*, which is one of the finest new vessels in the French Navy. This ship is a first-class protected cruiser having twin screws. She is 389 ft. 9 in. in length between perpendiculars; 53 ft. 6 in. beam at the water-line; 35 ft. 11 in. deep; has a mean draft of 22 ft. 10 in., and a displacement of 7,045 tons.

The hull is built of steel, but the stern-post, keel and the plating of the protective deck are of iron. This deck covers the engines, boilers and magazines, which are also protected by numerous water-tight bulkheads and by the belt of cellulose.

The contract speed of this ship was 19 knots under forced draft, and this she maintained at the trial. Her highest speed with natural draft is about 16 knots. The coal capacity is 900 tons, when the bunkers are all filled. The ship carries three masts and can make a considerable spread of canvas.

This vessel was built under contract by the Société des Ateliers de la Loire, the contract price being $1,750,000.

The armament consists of six 16-cm. (6.3-in.) breech-loading rifle guns on the upper deck; ten 14-cm. (5.5-in.) guns in the battery; three 47-mm. (1.85-in.) rapid-fire guns, and twelve 37-mm. (1.46-in.) Hotchkiss guns. There are also seven torpedo-tubes placed above the water-line.

The engines are of the triple-expansion type and are horizontal. The cylinders are 43 in., 68 in. and 100 in. in diameter and 47¼ in. stroke. The low-pressure cylinders lie forward, and the crank shafts are fitted with coupling-boxes, so that when low powers suffice the low-pressure cylinders are put out of use, and the engines then work compound and develop 1,970 H.P., making 52 revolutions per minute. With natural draft and all the cylinders in use the power is 8,950, the revolutions being 89 per minute; and with forced draft the power is 11,370, and the revolutions 97 per minute. The safety valves are loaded to 150 lbs. The valve gear is Joy's. Steam is supplied by 12 boilers, arranged in groups of four in water-tight compartments. The shells are 14 ft. 3 in. in diameter and 10 ft. 9½ in. long. There are in each boiler three Fox furnaces, 3 ft. 7 in. in diameter. The grates are 7 ft. 7 in. long. The total grate surface is 930 sq. ft. The tubes are of brass, with the exception of the stay-tubes, which are of iron. The diameter inside of the brass tubes is 3 in., that of the iron tubes 2⅜ in. There are three chimneys, one to each group of boilers. They are 8 ft. 3 in. in diameter.

There is one surface condenser in each engine-room. Each contains 5,633 tubes, 0.7 in. diameter and 9 ft. 8 in. long. The total surface is 10,097 sq. ft., or about 1.75 sq. ft. per H.P. with forced draft, 2 sq. ft. with natural draft, and 8 sq. ft. when working compound.

The pumps are worked by distinct inverted cylinder engines. There are two air pumps in each engine-room 28¾ in. diameter and 19⅝ in. stroke. They are single-acting, and make 81, 138, and 150 double strokes per minute, according as the engines are working compound, with natural, and with forced draft. There is one centrifugal circulating pump in each engine-room, making 100, 147 and 160 revolutions per minute. The disk is 48 in. diameter. There are two feed-pumps, single-acting, in each engine-room, 6¾ in. diameter and 19 in. stroke. The main crank shafts are hollow, and 15¾ in. diameter, the hole being 7 in. in diameter. The connecting-rods are four cranks long. The piston-rods are 6⅝ in. diameter. The cylinders are jacketed all over the high-pressure and intermediate cylinders. The forced draft fans deliver into closed stokeholds. They are driven by compound engines, and each can deliver about 70,000 cubic yards of air per hour, at a pressure of 1 in. to 1¼ in. water. There are four of these blowing fans. The screws are four-bladed, of manganese bronze.

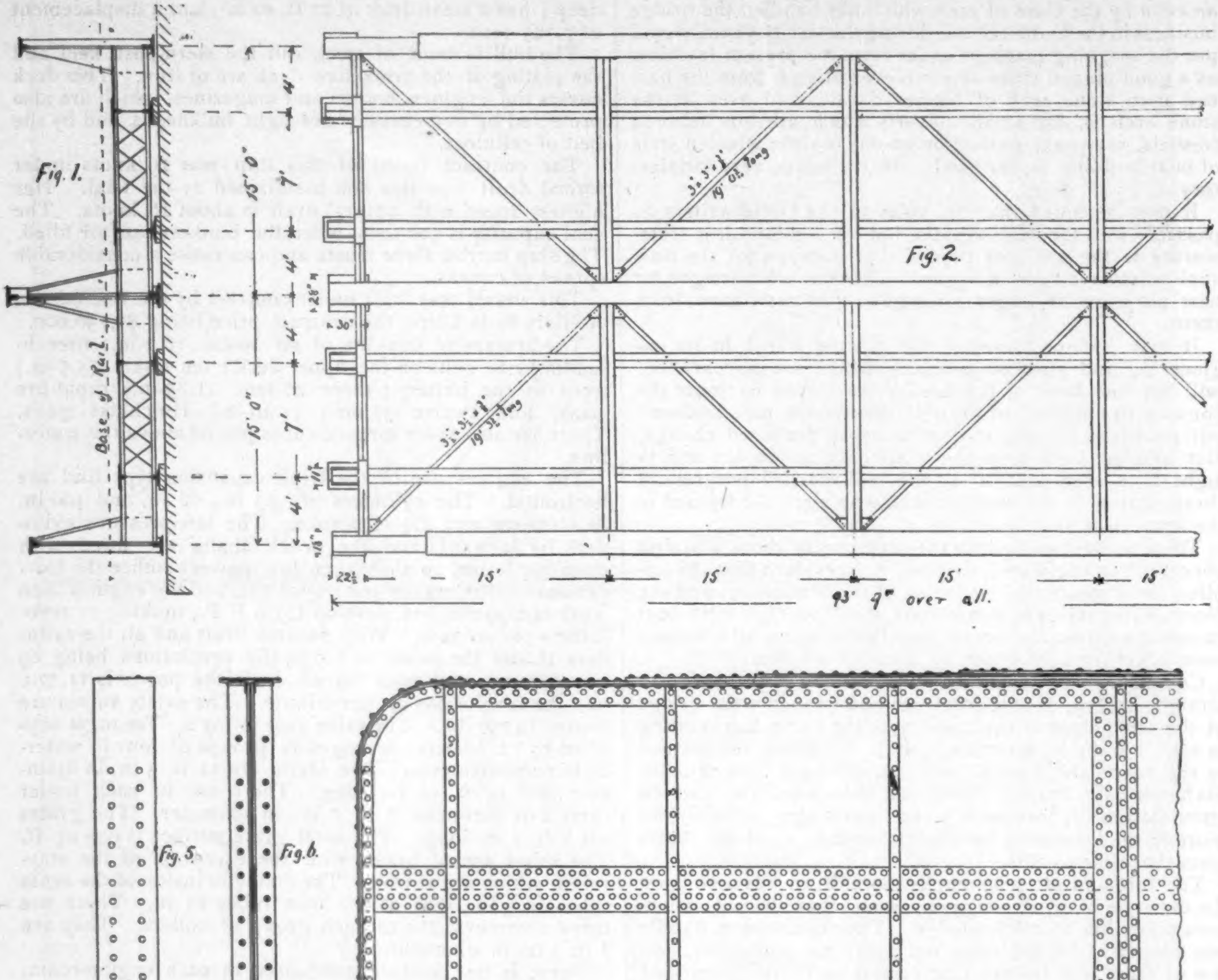
The main-bearing brasses are composed of an alloy of 84 copper, 16 tin, and 2 zinc. The bearings in the screw alleys are of copper 86, tin 14, zinc 2. Stuffing-box glands, etc., are of copper 88, tin 12, zinc 2. The boiler

fittings are of copper 90, tin 10, zinc 2. Brass tubing, so called, when used, is of copper 94, tin 6, zinc 2. The anti-friction metal is copper 4, tin 96, antimony 8.

The valve gear is so arranged that the cut-off in the high-pressure cylinder is variable between 25 and 74 per cent., intermediate cylinder between 25 and 70 per cent., and in the low-pressure between 37 and 79 per cent.

A NEW PLATE GIRDER BRIDGE.

THE drawings given herewith show a double-track plate-girder bridge recently built by the Passaic Rolling Mill Company, of Paterson, N. J., for the Delaware, Lackawanna & Western Railroad. In these figs. 1 and 2 are



WHITE'S BRIDGE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.

The ship is lighted by electricity. There are two Mangin projectors 2 ft. in diameter, and there are 300 incandescent lights in each compartment. Current is supplied by three large Gramme dynamos arranged in the engine-rooms.

Compressed air is supplied for the torpedoes by Brotherhood machines.

respectively an end elevation and a half plan of the bridge, showing the general arrangement. Figs. 3, 4, 5, 6 and 7 show the center girder; fig. 8 an end panel, and fig. 9 one of the beams which carry the floor.

The bridge is 93 ft. 6 in. span and has three girders; it is built entirely of steel. The center girder weighs 35 tons and the two outside girders 23 tons each. The

structure is proportioned for a moving load consisting of two 101-ton consolidation locomotives.

The illustrations show the construction of the bridge so well that but little further description is necessary. From figs. 1 and 2 it will be seen that the main girders are spaced 15 ft. apart. The floor-beams carried on the girders are also spaced 15 ft. apart; the diagonal bracing is of $3 \times 3 \times \frac{3}{8}$ angle-iron, except in the end panels, where it is $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$ in.

The center girder is 9 ft. in depth, the web being of $\frac{7}{16}$-in. steel plate; the general construction and bracing are shown in the drawings. The side girders are 8 ft. in depth, the web being of $\frac{3}{8}$-in. plate. The floor beams are 35 in. in depth and their construction, bracing and connections with the main girders are shown in fig. 9. The end studs differ somewhat in construction, as shown in fig. 8.

The stringers are spaced 7 ft. apart between centers and are 28 in. deep, having a web plate $\frac{3}{8}$-in. thick. Their construction presents no special peculiarities. In the work generally $\frac{3}{4}$-in. rivets are used.

The bridge is a good example of recent construction in the plate-girder type, which is now generally adopted in good practice for spans up to 100 ft., few trusses of less than that length being found of recent date.

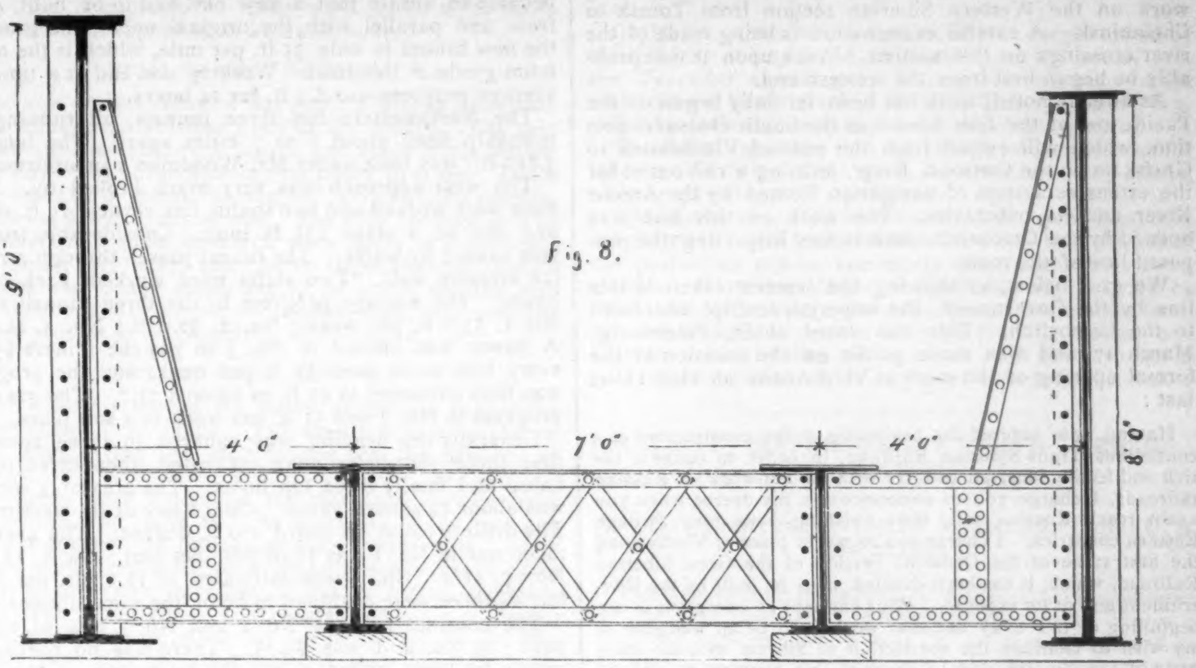


Fig. 8.

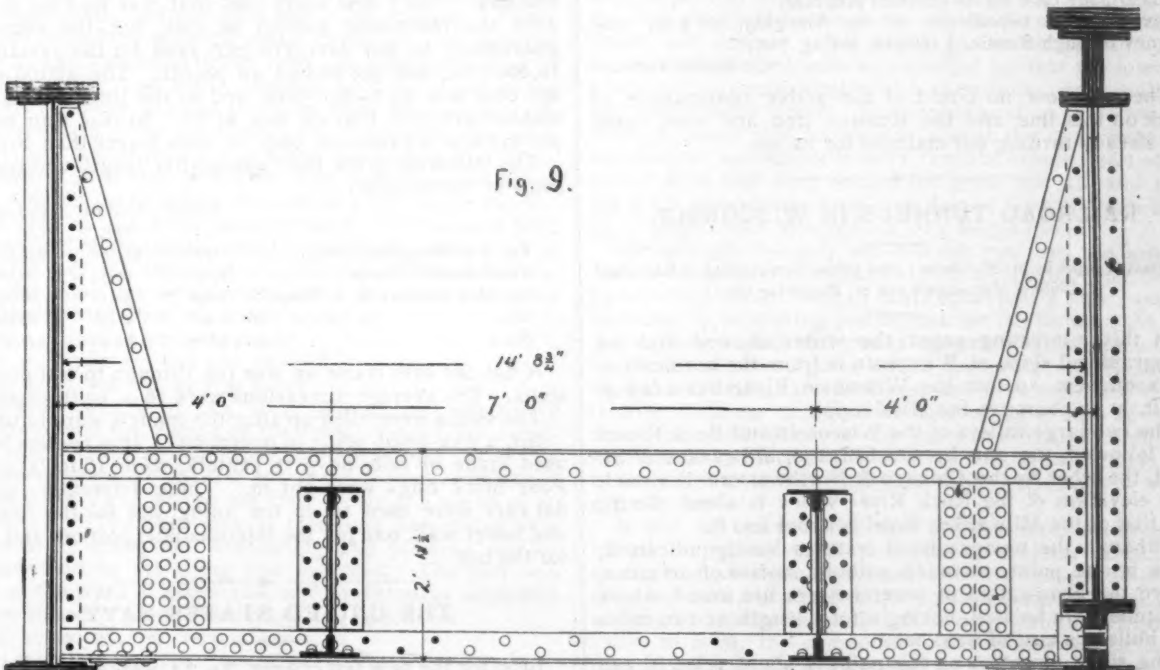


Fig. 9.

WHITE'S BRIDGE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.

BUILT BY THE PASSAIC ROLLING MILL COMPANY, PATERSON, N. J.

THE GREAT SIBERIAN RAILROAD.

THE preliminary work on the Siberian Railroad is being pushed forward. The engineer corps are in the field on the extension of the Samara-Oufa-Zlatooust line eastward, and are also completing the arrangements for beginning work on the Western Siberian section from Tomsk to Chelabinsk. A careful examination is being made of the river crossings on this section. Work upon it will probably be begun first from the western end.

As already noted, work has been formally begun on the Pacific end of the line, known as the South Oussouri Section, which will extend from the port of Vladivostok to Grafskaia on the Oussouri River, forming a rail out'et for the extensive system of navigation formed by the Amoor River and its tributaries. The work on this line was opened by the Czarovitch, who is now inspecting the proposed line of the road.

We give below, as showing the interest taken in this line by the Government, the imperial rescript addressed to the Czarovitch. This was dated at St. Petersburg, March 17, and was made public on the occasion of the formal opening of the work at Vladivostok on May 11–23 last:

> Having now ordered the beginning of the construction of a continuous Trans-Siberian Railroad, in order to connect the rich and fertile Siberian country with the net-work of Russian railroads, I charge you to announce this my decree when you again reach Russian soil, after finishing your tour through Eastern countries. I charge you to put in place at Vladivostok the first stone of the Oussouri Section of the Great Siberian Railroad, which, it has been decided, is to be built by the Government and at its expense. Your eminent co-operation in the beginning of this truly national work is to be an evidence of my wish to facilitate the connection of Siberia with the other parts of the Empire, and to show to this country, so near to my heart, my care for its peaceful progress.
>
> Invoking the benediction of the Almighty on your long journey through Russia, I remain, loving you,
>
> ALEXANDER.

There is now no doubt of the active continuance of work on this line, and the Russian iron and steel works are already turning out material for its use.

RAILROAD TUNNELS IN WISCONSIN.

(Abstract of paper by Mr. Woodman; read before joint meeting of Engineers' Clubs of Minneapolis and St. Paul, May 8th.)

IN this interesting paper the writer showed that the topographical slope of Wisconsin is from the northeast to the southwest, so that the Wisconsin River has a fall of 900 ft. in its course to the Mississippi.

The two large valleys of the Wisconsin and Rock Rivers are followed, the one by the Chicago, Milwaukee & St. Paul, the other by the Chicago & Northwestern Railroad. The elevation of the Rock River valley is about 780 ft., and that of the Milwaukee Road is about 600 ft.

Although the topographical features hardly indicate it, there is one point, included within a radius of 10 miles, where the headwaters of several rivers are found, where six tunnels are located, having a total length of two miles and built at a cost of $700,000.

The ridge elevation at this point is about 1,300 ft. and the contours quite broken.

The tunnels are all in the same geological formation, the St. Peter sand rock, which underlies the Trenton lime rock. There is the same formation in the locality of St. Paul.

This sand rock generally consists of fine, pure sand, possessing very little cohesion, and is therefore very easily worked.

A peculiar geological feature of Wisconsin is the fact that, following the country down from northwest to southeast, the different formations from the earliest to the present one are in view.

Of 26 miles of road included within the above-mentioned circle, 21 miles are on a 66-ft. grade, which is almost a mountain grade. The difficulty of operating is apparent from the fact that a mogul engine with 18 × 24-in. cylinders can haul only 12 cars.

The Greenfield Tunnel, used by the Chicago, Milwaukee & St. Paul, is one-quarter mile long in a very soft portion of the rock. The tunnel had to be timbered, and finally it became so unsafe that a new one had to be built, 45 ft. from and parallel with the original one. The grade in the new tunnel is only 35 ft. per mile, which is the maximum grade of this road. Working one end at a time the average progress was 8.3 ft. for 24 hours.

The Northwestern has three tunnels, all running on township lines about 6 or 7 miles apart. The longest, 3,810 ft., was built under Mr. Woodman's supervision.

The west approach was very much broken up. Both ends were worked and two shafts, one vertical 75 ft. deep, and one on a slope 135 ft. long. Considerable trouble was caused by water. The tunnel passed through a regular artesian well. Two shifts were worked, each of 11 hours. The average progress in the three tunnels was: No. 1, 53.7 ft. per week; No. 2, 52.0 ft.; No. 3, 21.7 ft. A bonus was offered in No. 3 to pay the miners $5 for every foot made over 33 ft. per week, and the progress was thus advanced to 42 ft. as against 21.7. The greatest progress in No. 3 was 51 ft. per week in a soft place.

Generally the heading was squared in three rounds; first three foot-holes were excavated, then three mean holes, and finally three top holes. The area of a section was about 12 square yards. Only hand drills were used. The drillers could be heard 270 ft. distant. The average taken out in No. 1 was 12.98 yds. per foot; No. 2, 12.64; No. 3, 11.2. No. 3 was estimated at 11.1 yds. per foot, but all three were designed to be of the same dimensions.

The contract price in No. 1 and No. 3 was $4.50 per yard; in No. 2 it was $3.75. There was no particular reason for these prices, except the guesswork of the contractors. No. 3 cost every cent that was paid for it. In 1872 the contractor wanted to quit, but the company guaranteed to pay him $10 per yard for the remaining 10,000 yds., and yet he had no profits. The actual average cost was $5.79 per yard, and at the time the average cost of hard rock tunnels was $5.89. At that time out of 300 tunnels in existence, only 12 were longer than No. 3.

The following gives the comparative length and cost of some of the tunnels:

	Length.	Cost per foot.	Total cost.
The West Wisconsin Tunnel	882 ft.	$43.01	$37,913
New Greenfield Tunnel......... ...	1,230 "	60.54	80,518
No. 1 Northwestern R. R. Tunnel ..	1,694 "	58.44	98,971
No. 2 " " " ..	1,594 "	47.40	75,557
No. 3 " " " ..	3,810 "	64.90	247,272

A flat car with frame on was run through to test dimensions. The average dimensions were 16 × 19 ft. clear.

The shafts were filled up after the tunnels were finished.

No. 2 was lined while in operation. Iron centers were used made of rails on 3 ft. centers, using 16 ft. lagging. Four brick rings were put in. Three differently rigged flat cars were used to do the lining, one for the footing and lower wall, one for the intermediate portion, and one for the top.

THE UNITED STATES NAVY.

BIDS for the new fast cruiser, No. 13, were opened at the Navy Department in Washington, June 1. This cruiser, with a few slight alterations, is the same as No. 12, which is now under construction at the Cramp yards in Philadelphia. She will have three screws, and is intended to make a higher speed than any vessel yet built for the Navy. This ship has already been fully described in our columns.

Three bids were received: from the Union Iron Works, San Francisco, $2,793,000; William Cramp & Sons, Philadelphia, $2,745,000; Bath Iron Works, Bath, Me., $2,690,000. The contract will probably be awarded to the Bath Company. This is the largest vessel it has yet undertaken; it is now building two of the 1,000-ton cruisers and the Ammen ram. The plant has been

steadily increased, and it is understood that the works are in good condition to undertake this large ship. The engines will be built by the Quintard Iron Works, New York.

The general dimensions of this ship are: Length, 400 ft.; breadth, 60 ft.; depth, 30 ft.; displacement, 7,300 tons. She is expected to make a sea speed of 21 knots and a maximum speed of 22 knots an hour.

TRIAL OF THE "NEWARK."

The new cruiser *Newark* was given a trial to determine her qualities as a sea-boat early in the month. The ship started out from Hampton Roads and made a trip lasting three days, part of the time in very heavy weather. Trials were made as to speed, turning and manœuvring powers, and in the use of guns at sea. The ship behaved well in all these trials, some of which were made in a northeast gale with a very heavy sea. Some slight changes in deck features and minor points are to be made, and the ship will then probably be put into commission, and attached for the present to the Squadron of Evolution.

TRIAL OF THE "VESUVIUS."

The official report of the Board on the late trial of the *Vesuvius* has been made. The essential part of the report, after giving the preparations for the trial, is as follows:

Six shots were fired with the starboard and five with the middle gun, May 18. As the valve of the port gun was out of order, no projectiles were fired from it. From the six shots fired with the starboard gun a range curve showing the valve openings necessary for all ranges to more than 2,200 yards was constructed; but a similar curve could not be made for the middle gun. On May 19, six shots with the starboard gun were fired for accuracy. The valve openings for this firing were taken from the range curve, and corroborated it very closely. Three of these were fired with the vessel stationary and opposite buoy 1, and the other three with the vessel steaming at about 12 knots, and while opposite buoy 1. Also on the 19th three more shots were fired from the middle gun, using the data of the previous day for regulating the valve openings. The results of this firing and of that previously mentioned from this gun were very irregular and not of such a nature as to enable us to draw a fair range curve.

On May 20 the firing was resumed. Three shots fired at the word of command, the distance being estimated by a member of the Board at one mile, ¾ mile and ½ mile. The results of this firing were good; the shots fell at the distances stated from the buoys aimed at,

No. 1. Line, 43 yards beyond.
No. 2. 8 yds. rt., 104 yds. beyond.
No. 3. 24 yds. rt., 24 yds. short.

On the occasion of this firing the sea and wind were moderate, and the motion of the vessel, though not excessive, was not entirely conducive to good firing. After this firing was over, the *Cushing* towed the old cutter procured at the Navy Yard across the line of fire at a speed of 10 knots. The *Vesuvius* was at this time proceeding at a speed of 17 knots, and her rolling and pitching motion greater than in the firing just executed. The gun was fired at the word of command, and at distances estimated by the Board. These three shots fell as follows:

No. 1. 20 yds. left, 16 yds. short.
No. 2. 0 left, 300 yds. beyond.
No. 3. 8 yds. left, 275 yds. short.

These shots were fired at one mile, ¾ and ½ mile respectively.

In conclusion the Board would state as follows: The accuracy of fire of the starboard gun, under the conditions, we consider good; that of the middle and port guns we are unable to criticise, because the valves were not in satisfactory working order. The valve of the starboard gun has been modified by Lieutenant Seaton Schroeder, and worked satisfactorily throughout.

The range can be very readily altered; the setting of the valves can be changed to any point from extreme to shortest range in five seconds.

The effect of a moderate sea and wind on the general efficiency of the guns and their range is very slight.

Generally speaking, the vessel as a gun platform behaved very satisfactorily. There are many details concerning the steering-gear and conning-tower which could be very much improved.

As to the actual efficiency of the vessel for offensive purposes, the Board has little data on which to base an opinion.

On May 20 three shots were fired at a target towed by the *Cushing* at a speed of 10 knots across the line of fire, the *Vesuvius* steaming 17 knots; one of these would undoubtedly have struck a vessel. This the Board considered a favorable showing under the circumstances.

The Board considers that the fittings and appliances for loading and firing these guns, as fitted, are very crude, and capable of great improvement.

The Board would recommend that the guns should be carefully ranged in some suitable locality where the fall of the projectiles can be accurately determined from shore stations; that some simple and suitable sight should be fitted, and such changes made in the mechanism for loading and firing the guns as may be found advisable, and that the vessel be then subjected to such further tests as will fully determine her efficiency as a torpedo thrower.

RECENT EXPERIMENTS WITH ARMOR-PLATES.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

The armor-plate trials held at Annapolis, in September of last year, awakened throughout the United States a profound interest, which was by no means confined to military and naval circles. Not only were these tests the most important ever had on this side of the Atlantic, but the first conducted here under the modern conditions of attack and defense. One might go further and add that the results obtained were so unlooked for that the interest awakened was co-extensive with the whole armor-making and armor-using world. But pronounced as these results were, it would not be safe to accept the conclusions of enthusiastic newspaper writers that the whole question of armor-plate had been settled for good and all, and that the great compound-armor-clad fleet of Great Britain had, so to speak, been knocked out in a single round.

The struggle not only between the gun and the armor-plate, but between compound and all-steel armor has been, up to a very recent date, so fairly equal that a little caution is necessary in making predictions for the future. As the matter now stands the gun is unquestionably in the lead—that is, the best guns, under favorable conditions of range and target, can perforate any armor-plate of practicable thickness that can be carried by a ship of war. As to the armor-plate, all the more recent trials indicate a decided superiority of steel over compound armor. It is proposed to notice briefly the more important of these experiments.

It will be remembered that the first steel armor-plate aimed to oppose to a projectile a uniform resistance throughout its whole thickness, while the compound plate, then and now, offers to it the hardest possible steel face attached to a backing of soft wrought-iron. Theoretically, at least, the compound plate should be the most effective, since, while it opposes to the energy of the shot a sufficient hardness of face to make that energy act destructively against itself, its soft, tenacious back neutralizes the inclination of all hard plates to crack through and through and thus go to pieces. Practically, however, the compound plate has two serious drawbacks. The hard outer face is very prone to separate and fall away from its backing under the shock of striking projectiles, on the one hand, while upon the other the entire work of resistance is thrown upon the comparatively thin face—say less than half of the whole thickness of the plate. Once through this face and the soft iron back can bring but little additional aid in opposition to a carefully tempered steel projectile.

The two varieties of compound armor—the Cammell and the Brown, known also by the names of the inventors

as Wilson's and Ellis'—differ only in the methods of manufacture. In both a soft iron back is prepared and raised to a welding heat, and directly upon this, in the Cammell plate, is run the melted steel, which partially carbonizes a layer of the soft iron and creates a zone of semi-steel. In the improved Wilson process two layers of steel are run upon the soft back; one of very mild the other of very hard steel. In the Brown process the hard face-plate is prepared in advance, and then between this face and the iron back molten steel is introduced, forming a welding joint between the two. The plates, in both cases, are reheated and rolled down to the proper thickness. After being planed and machined to the proper form and dimensions, the faces of the plates are tempered and annealed to remove internal strains.

The difference in hardness between an all-steel and the face of an improved Wilson plate is indicated by the fact that while the former has only about 0.4 per cent. of carbon, the latter contains from 1.25 to 1.50 per cent.

It will be observed that nearly all the recent efforts to improve the quality of all-steel armor plate have been in the direction of securing this varying degree of hardness from front to back. In the Schneider plate the face is given a somewhat greater hardness by tempering in oil. By the Harvey process it is claimed that any mild steel plate can be so tempered as to give a great face-hardness, while the back retains its original quality, without creating any tendency to separation. Recent experiments indicate that this claim is well founded. In just what way an alloy of nickel improves an armor plate may be hard to explain. That it does improve it can hardly be questioned, giving it greater toughness and elasticity, if not greater hardness.

Wrought-iron armor held undisputed possession of the field until the Schneider all-steel armor was brought forward so successfully in the Spezzia experiments of 1876. A year later the compound plate, as at present manufactured, appeared, although Cammell & Company had entered the lists ten years earlier as manufacturers of a combination of iron and steel, but in these earlier methods attempts were made to weld the steel face directly to the iron back. The Schneider plate, in reaching its present state of excellence, has passed through many stages of hardness, from the steely iron of the first plates to those used in the Russian experiments of 1882, which were almost as brittle as cast-iron.

An extended series of trials were held at Portsmouth in 1888, in which steel and compound plates, all of English manufacture, were brought into competition. These trials clearly demonstrated the superiority of English compound over English all-steel armor plate. In the Helder (Holland) trials, November, 1889, four compound plates were tested—two English, a Brown and a Cammell (Wilson's), and two French, a St. Chammond and a Marrel, both made under the Wilson patent. The result showed that English were superior to French compound plates, and called attention anew to the excellency of English-made compound armor, without however, settling the question of superiority between it and the French all-steel plate.

The possession of a projectile, such as we now have in the Holtzer, that is practically indestructible, places the trial of armor-plate upon a much more satisfactory footing than it has ever been before. It is now possible by calculation to match gun against plate in such a way as to give to the projectile a striking energy barely sufficient to perforate the plate before it. Under such conditions to measure the relative resisting qualities of rival plates is not a difficult matter. For this reason the trials that have been held during the past 12 months are particularly valuable. There has been no great overmatching either on the side of the gun or of the armor-plate. A brief examination into the details of the Ochta and Annapolis trials of last autumn, and the more recent ones at the latter place, will give a fair idea of the present state of armor development. It should be said that, excepting the Annapolis trial, the official reports are not at hand. The details given are, however, believed to be correct.

SCHNEIDER. NICKEL. CAMMEL.

FIG. 1. VIEW OF ANNAPOLIS PLATES AFTER FOUR SHOTS EACH.

THE ANNAPOLIS TRIAL.

This trial, the most important ever had in this country, was originally intended as a test for Holtzer projectiles, and for this purpose the two French plates were purchased. Subsequently, at the request of Cammell & Company, it was made a competitive armor-plate test, and opened to all comers. The three plates entered were the two French steel and an English compound, Wilson's patent.

The Schneider plates were each 10.5 in. and the English

10.6 in. in thickness, and all 6 × 8 ft. The all-steel plates contained about 0.33 per cent. of carbon ; the nickel steel between 4 and 5 per cent. of nickel alloy. The backing was 36 in. of oak timber, well braced, behind which was a well-rammed mound of earth.

The gun was a 6 in. B. L. R., 35 calibers in length. The projectiles, Holtzer forged chrome-steel shell, weighted with sand and fragments of iron to 100 lbs. each. The charge in each case was 44½ lbs. brown prismatic powder ; the striking velocity of the projectile 2,075 foot-seconds, and the striking energy 2,988 foot-tons. The targets were arranged in a semi-circle, 28 ft. from the muzzle of the gun.

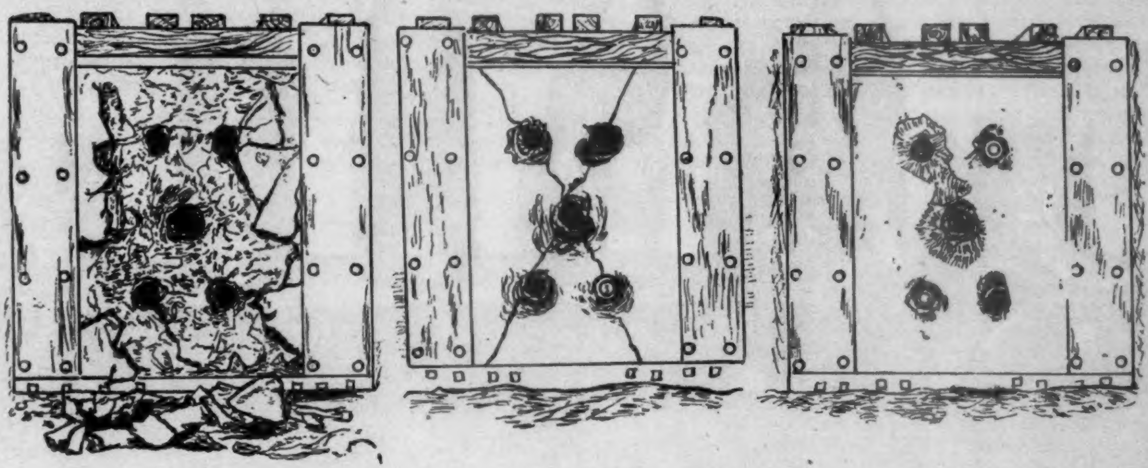
The trial began on September 18, when four shots were fired at each of the plates from the 6-in. gun, beginning in the lower right-hand and ending in the upper left-hand corner of the plates. Four days later a single shot from an 8-in. rifle was fired at the center of each plate. In the second trial a 210-lb. Firth armor-piercing shell was thrown by 85 lbs. of brown prismatic powder, with a striking velocity of 1,850 foot-seconds and a striking energy of 4,980 foot-tons.

The accompanying figures will give a better idea of the appearance of the plates at the end of the trial than any written description can do. To summarize briefly, the effects of the shot and the behavior of the plates were as follows :

Schneider All-Steel Plate.—The first projectile penetrated about 10 in. and stuck, apparently uninjured. The penetration of the other three was about 12 in. in each case. All rebounded, two remaining intact except for a little shortening, the other breaking up into 5 or 6 pieces. The 8-in. shot penetrated about 15 in., rebounded and broke into three large pieces. About each shot-hole there was a front bulge of about 1 in. and a projecting fringe, and a back bulge about three times as great. The back bulge of the 8-in. shot was 6.25 in. At the end of the first day's trial, save for a few short surface cracks, the plate was apparently in good condition. The 8-in. shot started four through cracks, radiating from the center in the form of an X, as shown, but these were only through in places, and the plate still had strength to support its own weight.

The *Nickel Steel Plate.*—The first and fourth projectile fired on the first day broke up after penetrating 13.5 in. and 7 in. respectively ; the second and third stuck after penetrating 15.5 in. and 12.5 in. respectively. The front bulge averaged a little more than an inch ; the back bulge was from 4 to 6 in. The 8-in. shot formed a 3.5 in. crater in back of plate. There were no visible cracks on the plate.

The *Compound Plate.*—The first three projectiles, on the first day's trial, perforated the plate and lodged in the oak backing. The fourth passed through both plate and backing and broke up. The 8-in. shot tore a hole through plate, backing, and penetrated 15 ft. into the earth behind. At the end of the first day's firing the steel face above the upper shot holes had been thrown off, the face was badly cracked elsewhere, and the whole plate on the verge of disintegration. The 8-in. shot wrecked the plate, leaving but a few fragments of the steel face in place ; the front scaling off to a maximum depth of about 6 in. The following is the summary of the report of the Board :



CAMMEL. SCHNEIDER. NICKEL.

FIG. 2. FRONTS OF THE PLATES AFTER THE ANNAPOLIS TRIAL.

FIG. 3. BACKS OF PLATES AFTER THE ANNAPOLIS TRIAL.

The *Compound Plate* was perforated by all projectiles, and its steel face was destroyed. Two of the shells passed completely through both plate and backing.

Both *Steel Plates* kept out all projectiles, the All-Steel Plate showing slightly greater resistance than the Nickel Steel Plate, but the former was badly cracked by the 8-in. shell, while the latter remained uncracked. The Board, therefore, places the three plates tested in the following order of relative merit :

1. Nickel Steel ; 2. All Steel ; 3. Compound.

In the figures referred to fig. 1 represents the plates

after the four shots, at the end of the first day's trial; fig. 2 shows the appearance of the fronts of the plates after the 8-in. shot had been delivered; fig. 3 the backs of the plates after they were removed from their backing at the end of the trial; fig. 4 is from a photograph of the six recovered 6-in. projectiles.

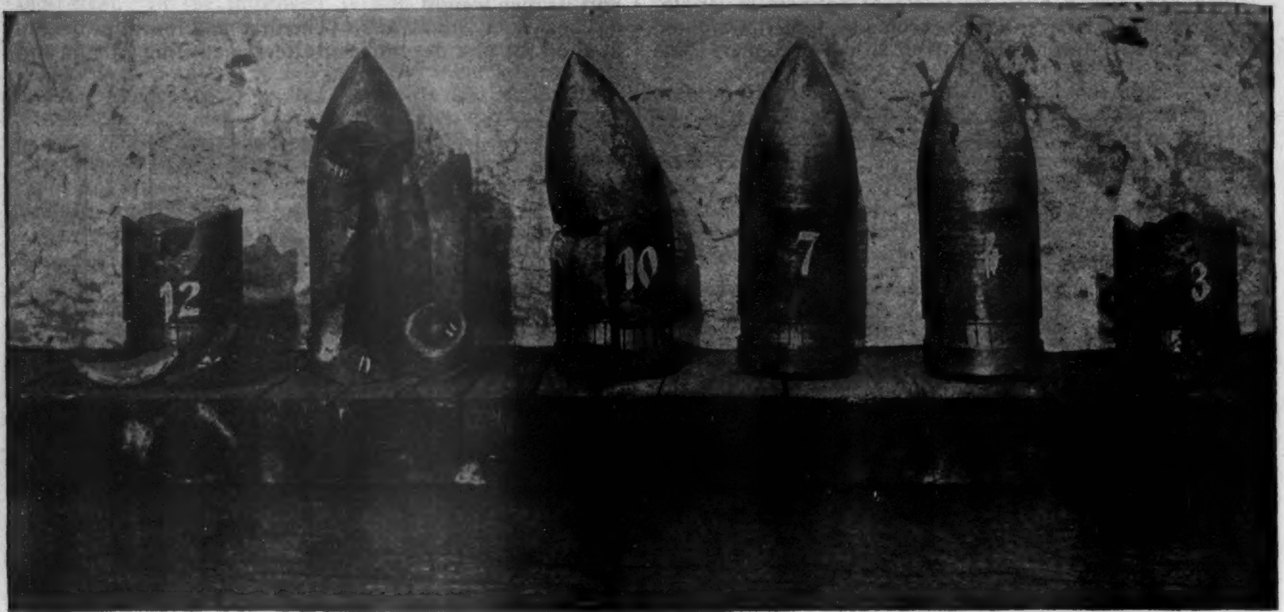


FIG. 4. RECOVERED SIX-INCH PROJECTILES, "ANNAPOLIS" TRIAL.

(Figures refer to Serial Number of Rounds.)

I am indebted to the courtesy of the United States Naval Institute for the use of the plates of figs. 1 and 4.

THE OCHTA TRIAL.

This took place at the Polygon of Ochta, near St. Petersburg, on November 11 last, under the direction of Russian naval officers. It is particularly interesting in that the conditions of the trial were very similar to those at Annapolis, while the results obtained were of a widely different character.

The gun was a 35-caliber, 6-in. B. L. R., of Russian make; the projectiles were likewise of domestic manufacture, but made upon Holtzer's system and under the direction of his own men. They weighed about 90 lbs. each, were 16 in. in length, and had a calculated penetration of 10 in. of steel or steel-faced armor. The average striking velocity of the five projectiles fired was a little over 2,000 foot-seconds and the striking energy about 2,500 foot-tons. The range was about 130 yards.

Three plates were submitted for trial: 1. A Schneider oil-tempered and hammered all-steel plate, said to have contained 3 per cent. of nickel; 2. A Vickers solid steel, rolled and hydraulic pressed, but untempered plate; 3. A Brown (Ellis) compound plate. The backing was 12 in. of pine timber well braced. A Kolpoui (Russian) compound plate, made under the Wilson patent, had been ordered for this trial, but for some reason was not ready for trial until some days later.

Five shots were fired at each plate, whose appearance at the end of the trial is shown in fig. 5. In this figure the through cracks are indicated by the letter "t." Briefly stated, the effects produced were as follows:

Schneider Plate.—None of the projectiles got their points through the plate. The maximum penetration was 11.4 in., the metal bending back beyond the back face of the plate. The minimum penetration was 9 in. Three of the projectiles rebounded, somewhat set up and two broke up. The plate was badly cracked, as is seen, the four corners being broken away, but held in place by the bolts.

The *Vickers Plate.*—Two of the projectiles lodged in the plate, their bases being 2 in. and 5 in. past the front face of the plate, with their noses presumably in the backing; three of the projectiles rebounded, one partially breaking up, the others in good condition. The minimum penetration was 11.75 in., the point of one projectile getting 3 in. beyond the back of the plate before rebounding. There were a number of through cracks, one corner being pretty well broken up.

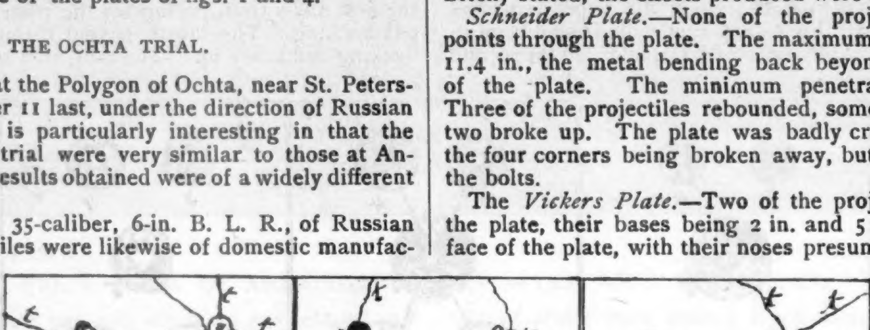


FIG. 5. THE PLATES AFTER THE OCHTA TRIALS.

The *Brown Plate.*—The minimum penetration was 13 in.; two projectiles stuck in the plate, their bases projecting 2¾ in. and 3 in. from its face; three passed entirely through both plate and backing. There were a number of through cracks and some breaking away of the metal around the shot-holes.

Satisfactory details of the trial of the Kolpoui-Wilson compound plate, which took place a few days after the above, are wanting. It is reported that five shots were fired under like conditions as those of November 11; that one shell reached the backing; that there were no through cracks, and that the plate behaved better than any of the three tested on that date.

In the above trial, leaving the Wilson plate out of the account, the Schneider plate, for purposes of protection, was unquestionably the best, while the Brown compound made the poorest showing. *The Engineer* (London), whose preference one may suppose to be naturally for English plates, speaking of this trial says:

There is less penetration in it (Schneider's) than in either of the others. The center has failed most, yet taking it altogether a ship would have been more completely protected by this plate than by either of the others. The bulges would probably not have been sufficient to break framing behind them, while against perforation—and this is the evil to be specially dreaded by ships—this armor would have afforded complete protection, and then the time for replacing the plates would be less and there would be less repair needed to the structure of the ship than in either of the other cases. . . . Vickers plate held together admirably; . . . from the front hardly an atom was detached; . . . the behavior of the plate, in some respects, suggested the presence of nickel, yet analysis and the maker's statements both tell us there was none. . . . We think that it will be felt that the all-steel has beaten the compound more decidedly than we first reported. . . . Curiously enough, if the Annapolis plates' backs and fronts be compared with those tested at Ochta, the relative behavior of the nickel and other steel plates is reversed. At Annapolis the nickel plate admitted of more penetration, but held capitally together. At Ochta, the Vickers plate, with no nickel, behaved in this way, as compared with the Schneider, containing 3 per cent. of nickel.

(TO BE CONTINUED.)

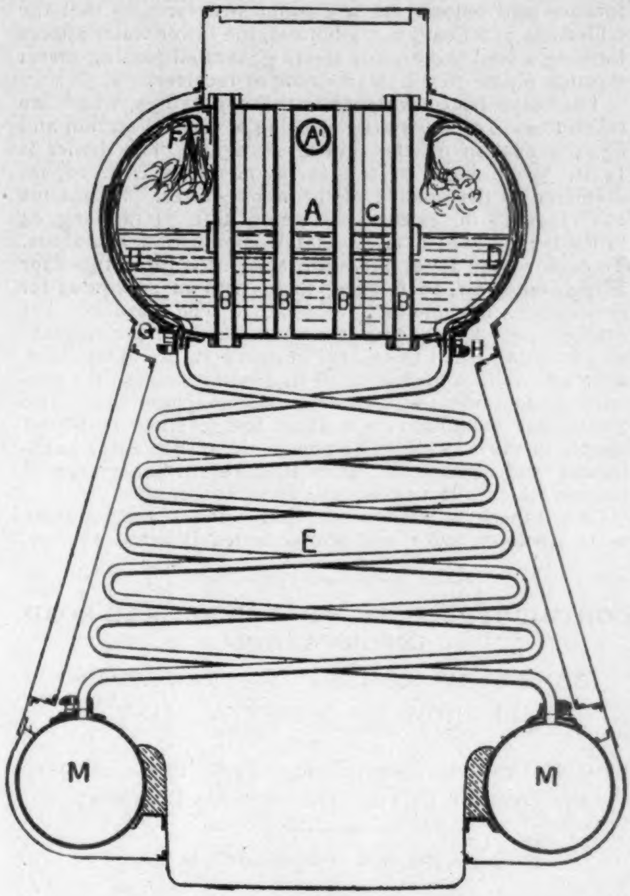


FIG. 1.

NEW TUBULOUS BOILERS.

MR. B. H. THWAITE, of Liverpool, England, has recently invented a tubulous boiler, for which numerous advantages are claimed. The accompanying illustrations, from the *Steamship*, show this boiler, fig. 1 being a cross-section, fig. 2 a longitudinal section, and fig. 3 the details of the joint on a larger scale.

From fig. 1 it will be seen that a steam drum, *A*, of the form shown is provided with a number of vertical tubes, *B B*, which act as stays and also serve to distribute more equally the products of combustion, increasing the heating surface and drying the steam. These tubes pass through a separator plate, *C*, fixed in the steam drum at a point just above the surface of the water, the holes in this plate through which the tubes pass being 2 mm. in diameter larger than the tubes. At each side of the steam drum, jackets *DD* are provided, with which each set of the generating tubes *E E* is in communication. At the upper part of these jackets an opening for steam into the steam drum *A* is provided, which may consist of a num-

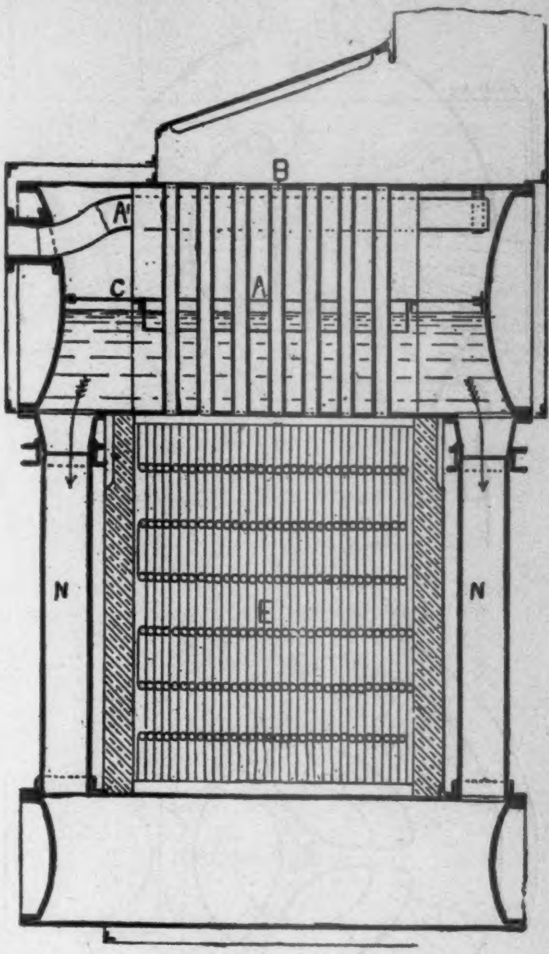


FIG. 2.

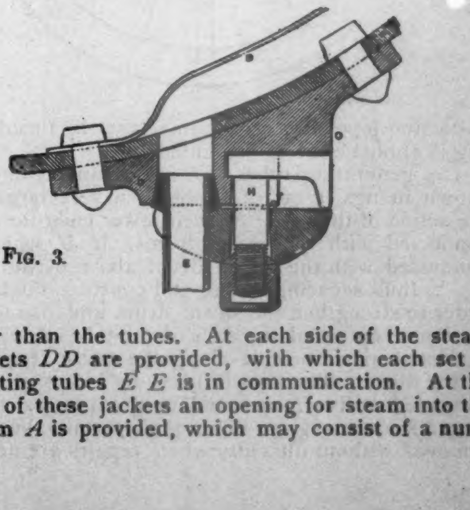


FIG. 3.

ber of small holes, *F F*, or a longitudinal knife-edged slot. By this arrangement the ascending volume of water and steam, instead of bubbling up through the body of water, emerges from the openings *F F*, the water, by reason of its greater momentum, impinging upon the surface of the water in the drum while the steam enters the perforated

Fig. 4.

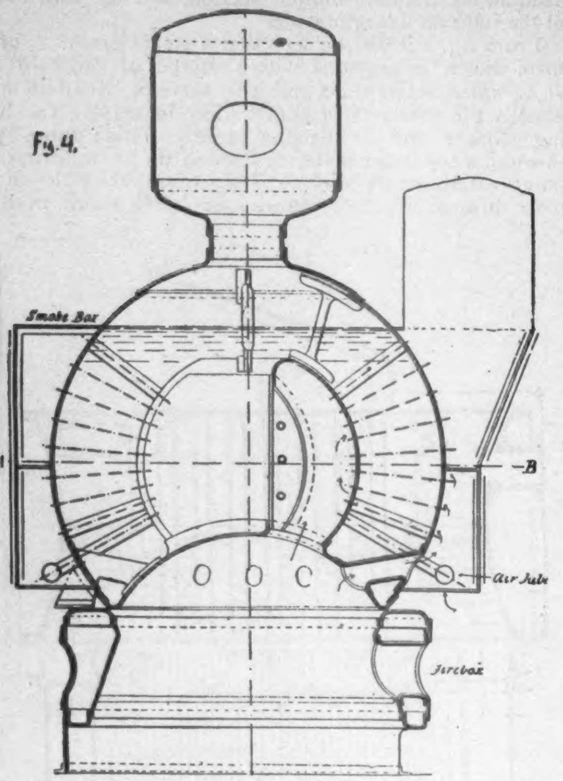
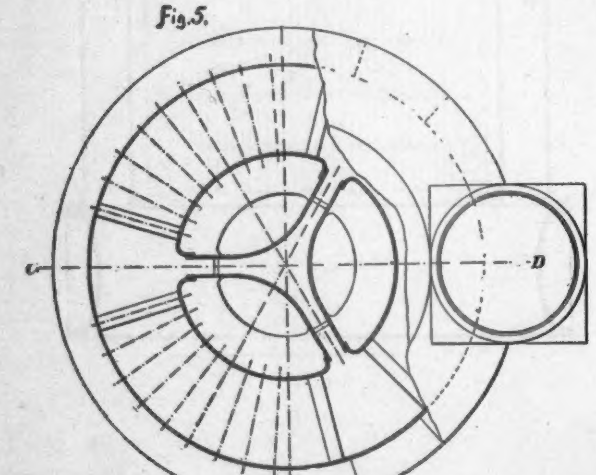


Fig. 5.



collecting pipe *A'*. It is claimed that by this device priming is almost entirely prevented.

The generating tubes *E E* are arranged in the manner shown in figs. 1 and 2, exposing a very large surface to the action of the fire. At their lower ends these tubes are connected with two water drums, *M M*, which are also connected with the steam drum above by the pipes *N N*, fig. 2, thus securing a free and constant circulation. In order to strengthen the steam drum and also to prepare it for the reception of the ends of the tubes *E E*, a strip, *G*, is riveted upon the side along the entire length occupied by the tubes. The joint is made by means of clamps and T-headed bolts *H*, inserted in grooves, as shown on a larger scale in fig. 3. This plan permits the tubes to be removed without difficulty when repairs are needed.

The advantages claimed for this boiler are great evaporative efficiency, freedom from priming, free circulation of water, and facilities for repair or renewal of tubes.

The grate is placed between the two cylinders *M M*, which are protected by fire-brick, as shown in fig. 1, and the entire boiler is surrounded by an iron casing.

In figs. 4 and 5 is shown another new form of high-pressure boiler devised by H. B. Buckland, and recently tested at Shields, England. This boiler, which the inventor calls the "Stanley," is spherical in form, the lower portion being reversed to form the crown of the furnace, the combustion chambers, three in number, taking away direct the greater part of the gaseous products and passing them through the upper tubes into the smoke-boxes, and hence to the funnel. Large lower tubes are also provided in the lower portion of the boiler to take away part of the gases, which are returned through the ordinary tubes into the combustion chamber. The sides of the furnace and bottom are a distinct structure, so that the boiler has practically a dry bottom, the lower water spaces forming a feed-heater, any steam generated passing direct through piping to the steam dome or receiver.

The boiler tested is shown in the engravings, which are taken from *Industries*, fig. 4 being a vertical section and fig. 5 a section on the line *A B*, fig. 4. This boiler is 14 ft. 3½ in. high, 7 ft. 6 in. diameter, or 8 ft. 10¾ in. diameter to the outside of the smoke-boxes. It contains 252 tubes 2¾ in. external diameter, 1 ft. 7½ in. long, 84 tubes being fitted to each of the combustion chambers. To each of the latter there are also fitted three tubes for admission of air, each being fitted with an apparatus for regulating the quantity admitted. The furnace was bricked round, reducing the diameter of the fire-grate to 4 ft. 3 in., equal to an area of 14.18 sq. ft. The chimney, 2 ft. 6 in. in diameter, 26 ft. 4 in. high above the fire-bars, is common to all the combustion chambers. The boiler was submitted to a short test, lasting 1½ hours, simply to show its steaming power, the results being satisfactory and considered better than the ordinary type of marine boiler. It was worked up to 85 lbs. only.

One of these boilers has been put in the steamer *Napier* as an auxiliary boiler, and will be tested in actual service.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XVIII.—HOW TO DESIGN A PAINT.†

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 254.)

In the April number we discussed the question of How to Design a Paint, in answer to the question, "What pigment shall be used?" This leaves two other points still to be discussed. These are, first, "What liquid shall be used?" and, second, "What proportions of pigment and liquid give best results?"

First, in regard to the liquid. With the present state of our knowledge it almost goes without saying that the liquid which must be used to hold pigment on a surface is necessarily, largely at least, linseed-oil, since this oil is abundant, is low in price, and has the interesting property when exposed to the air of changing chemically from a more or less greasy liquid to a leathery solid, which serves ad-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

† Continued from No. XV, in the April number.

mirably as a means of holding pigment on a surface. It is, of course, well known that there are a number of other oils which have this property, notably poppy-seed oil and hempseed oil, which, if our experiments are to be trusted, is often a constituent of the linseed-oil of the market, and also, to a certain extent at least, some of the fish oils. It is hardly necessary to add that the class of oils that is or may be used, as the principal portion of the liquid in paints, is known as the "drying oils." It may be mentioned also that there are a number of oils called "semi-drying oils," the most common of these being, as we understand the matter, cotton-seed oil. None of the drying oils, however, so far as our observations go, except linseed-oil, is sufficiently cheap and abundant to be used with success as the principal portion of the liquid of the paint. A little further on we will speak about linseed-oil substitutes.

Let it be granted, then, that in the present state of our knowledge and of the market, linseed-oil must necessarily constitute the principal portion of the liquid to be used in paint. But raw linseed-oil alone, at least with some pigments, will not make a satisfactory paint, because it dries so slowly. It has been previously stated that raw linseed-oil alone spread on glass requires about four days to dry, and when mixed with many pigments it does not dry much more rapidly than this. With white lead, which is of itself more or less of a dryer, the time is shortened somewhat, and the same thing may also be said, we think, of red lead, and to a certain extent with pigments containing oxide of manganese, such as umber; but in general the pigments themselves do not sufficiently facilitate the drying, so that it would be safe to say a paint might consist of pigment and raw linseed-oil. Accordingly more or less of a material called japan is added to a paint and becomes really a portion of the liquid. Japan, in brief, may be defined as a soap made by combining lead and manganese oxides with linseed-oil or with shellac, or in some cases with other oils, which soap is subsequently dissolved in spirits of turpentine or benzine. In our experience the japans of the market vary a great deal in their capacity to facilitate drying. With some of them the greater the amount of japan present the smaller the time required for drying. With other japans an increase in the amount of japan beyond a certain percentage retards the drying, so that it is very difficult to say how large a percentage of japan should be used in an oil in order to give successful results. We are accustomed with any new japan to mix it with raw linseed-oil in the proportions of 5.00, 10.00, 20.00, 30.00, and 40.00 per cent. of japan in the mixture, and to spread the various mixtures on different pieces of glass, and see which one dries the best. This enables us to use that japan wisely.

We prefer japans which can be used in small amount, and the best japan which we have ever seen gave most rapid drying when used to the extent of about 95.00 per cent. raw linseed-oil and 5.00 per cent. japan. We prefer a japan of this nature, and would likewise think it unadvisable to use a japan which required more than 10.00 per cent., or at the utmost 15.00 per cent. of japan to 85.00 of raw linseed-oil.

It should be stated that many of the japans of the market have kauri or other copal gums in them as constituents. We regard this as a mistake, as the gum occupies space which could be better occupied with other material. If it is desired for any purpose to have special gloss on the paint, a little varnish added to the paint is better than to have this material introduced through the japan.

Thus far, then, the liquid to be used in painting is found to consist of raw linseed-oil, with a sufficient percentage of japan in it to produce satisfactory drying, the japan having all the way from 40.00 to 60.00 per cent. of its weight of spirits of turpentine, so that in reality the liquid used in most painting consists of raw linseed-oil, the soaps which are characteristic of the japan, which likewise dissolve in the oil, and the turpentine introduced with the japan. In addition to this, as will be seen a little later, we are inclined to favor a still further percentage of turpentine as a means of diluting the paint for spreading. The amount of this and the reasons why will be explained further on. The three things mentioned—namely, raw linseed-oil, the lead and manganese soaps introduced with the japan, and turpentine, both as a constituent of the japan and as a means of diluting the paint for spreading, we regard as the best practice, and as legitimate materials to form the liquid part of paint.

The practice of many painters, and especially the practice of paint manufacturers in making many of the cheap ready mixed paints of the market, differs very widely from these three simple constituents. It is not at all uncommon to find in the market paint mixed with so-called linseed-oil substitutes. These substitutes, which we have examined, have been, largely at least, either petroleum product mixed with fish oils or doctored in other ways to make them dry, or rosin oils with a greater or less amount of fish oil, or possibly linseed-oil doctored up in some other way so that it would dry, or rosin oils, or petroleum product with japans. The various mixtures are difficult to separate, and the usual test which we have put the so-called linseed-oil substitutes to is to determine their rate of drying. We have never run across, in our experience, any of these substitutes—with we believe one possible exception—that were not so slow in drying that this feature alone condemned them, and so we have not tried in every case to find out exactly of what the substitute consisted. We have had samples which would not dry in four or five days, where good linseed-oil paint, properly made and applied, would dry in eight hours.

We would not at all like to be regarded as saying that nothing can be found which will take the place of linseed-oil, for to our minds linseed-oil has a good many defects, and we should only be too glad to find some substance which could be used successfully as the liquid part of paints that would be free from these defects, notably the permeability of the dried linseed-oil to water. If some liquid could be found which would dry as rapidly as linseed-oil, that was as durable as dried linseed-oil, and that would make a paint which would absolutely repel water, it certainly would be a great discovery, and would undoubtedly prove of great value to the person who first brought it forward. Thus far in our experience we have never seen such a liquid.

Our experience with fish oils in place of linseed-oil has not been very extended. Usually, so far as our experiments have gone, they dry more slowly, and do not offer much advantage in the way of price over linseed-oil. Furthermore a paint mixed with fish oil is apt to dry spotted and sticky. Quite a notable exception to this general criticism of fish oils is a prepared fish oil, which has recently been brought to our attention. This oil, so far as our knowledge goes, has been treated in such a way that it dries fully as rapidly as linseed-oil, but our experience with it, especially as to its durability and behavior on exposure to the weather, is so meagre that we are hardly willing to do anything more than mention the matter as above. We are constantly on the lookout for any modifications of paint liquid which will produce better results, and only regret that we are compelled to say that thus far we have found nothing to take the place of linseed-oil.

Two points further in regard to paint liquid. We have already mentioned that spirits of turpentine is a legitimate constituent of paint mixed ready for spreading. We are finding, however, that spirits of turpentine in the market is becoming adulterated more or less with petroleum product, and this is leading us to examine all shipments of this material.

The question may be asked, What objection is there to a small amount of petroleum product in a paint, introduced either through the turpentine or, as it is more commonly introduced in the market—namely, as benzine? We are quite well aware that many practical painters, and especially many manufacturers of ready mixed paints use large quantities of benzine, both as a constituent of their japan and to dilute the paint with to prepare it for spreading. We have examined many samples of mixed paint which contained large percentages of petroleum product, introduced either as benzine or as a constituent of the turpentine. So far as the introduction of petroleum product of any kind along with the turpentine is concerned, we will say that, of course, it is a fraud to buy as turpentine a material mixed with petroleum product, but to our

minds there is a still more serious objection to the use of turpentine adulterated with petroleum product or benzine in mixed paint. This objection lies in the tendency produced by the petroleum product, either benzine or the ordinary adulterated spirits of turpentine, to cause the paint to peel. We have made positive experiments on this point, and confirm by these experiments what the practical painters with whom we have talked on the matter affirm to be their experience—namely, that a paint containing any considerable amount of any petroleum product, as a constituent of the liquid, peels, and accordingly it will wear worse than if simple raw linseed-oil, japan and turpentine were the liquid constituents. The reason for this is not difficult to find. Very few of the petroleum products of any kind are free from paraffine wax, or non-volatile members of the paraffine series or other non-volatile substances. It follows, therefore, that when the paint dries the volatile part of the benzine or other petroleum product passes away, while the non-volatile part remains and is soaked up into the wood. But this soaking up of an oily, slippery substance like paraffine wax, or the non-volatile substances into the wood prevents the layer of paint from adhering to the wood surface. Our belief in the inferiority of benzine or other petroleum products as a constituent of paint is so strong that we are quite inclined to condemn any paint containing benzine. The non-volatile part of the turpentine, as is well known, is very adhesive and sticky, and helps the oil to hold the paint on the surface. The non-volatile part of any of the petroleum products fills the pores of the wood and prevents the paint from adhering, or, what amounts to the same thing, causes it to peel and scale off much more rapidly. Benzine is a good thing for the paint manufacturer, in that it is very cheap in price, and causes the paint to deteriorate so rapidly that buildings must be repainted every year or two. It is a bad thing for the consumer, who is interested in having a paint as durable as possible.

There is another feature of the use of benzine which should not be forgotten—namely, that in a closed paint shop, having a good many painters, the amount of benzine given off might be large enough to cause danger of an explosive mixture being formed in the shop. It is quite well known that several serious accidents have occurred from trying to clean carpets with benzine, and the same state of affairs might result from the use of a large amount of paint containing benzine in paint shops. Our belief in the inferiority of this material as a constituent of paint is so strong that we recommend that none of it be kept on the Company's property or used in the shops anywhere if its use can be avoided.

This is the place to speak of one point further in regard to paint liquid. We are quite well aware that the relative merits of boiled and raw linseed-oil have been very much discussed, and that there is a very strong prejudice among a large number of painters in favor of boiled oil. We are compelled to confess, however, that all our experiments, and we have made a good many of them, do not lead us to think that boiled oil is anything like as valuable as many master painters claim. We have never seen a sample of boiled oil which would dry as rapidly and as free from "tache" as good raw oil mixed with the proper amount of japan. Adding to this the fact, which is well known by those who are well informed, that quite a large percentage of the boiled oil of the market is not boiled oil at all, but is simply raw oil treated in the barrel with a little japan or oil dryer, we are inclined to think that the value of boiled oil has been over-estimated. We do not ignore the fact that the influence of the heat changes the oil somewhat, but to our minds this change is the very thing which should be avoided. Good raw oil properly dried is, so far as any knowledge which we have been able to get, as durable and as satisfactory in working as any boiled oil ever made. We do not, therefore, favor the use of boiled oil, either in the grinding or mixing of paints.

Let us turn now to the question at the head of this article —namely, what proportions of pigment and liquid shall be used? Upon this point the practice of painters, as well as that of the manufacturers of ready-mixed paints, differs very widely, and we have sometimes been inclined to think that in no one of the three elements that enter into painting is there so much fraud as in the proportions of pigment and liquid. Where the coloring power of the pigment is strong, we have seen paints so diluted that they were practically little more than a wash. Of course those familiar with the characteristics of the trade know that there is a great difference of practice in the kinds of pigment used, and also in the nature of the liquid used; but if we may trust our experience it is also true that there is very great variation, quite to the detriment many times of the buyer, in the proportions of pigment and liquid.

It is not at all easy to give a definite statement in regard to proportions of pigment and liquid, since there are a number of elements which enter into the problem, and a rule which would be applicable to one liquid and one kind of pigment would not be applicable with others. There are also a number of preliminary points which must be considered before we can give definite figures for proportions of pigment and liquid. We will take up these points one by one, and reach definite conclusions on them, and later will give the results of our study in the matter of proportions.

First of all, it should be borne in mind that what follows in regard to proportions applies only to what is known as house painting in distinction from carriage painting. It will be remembered that this distinction has been drawn in previous articles, and in this article we do not profess to give the proportions of pigment and liquid, which should be made use of for successful carriage painting, in which the paint is used almost exclusively for the color and not for protection. This article applies to paints used both for color and for protection.

At the very outset of the discussion we are met by a distinction which must be carefully cleared up before we can do anything definite—namely, does our discussion of proportions apply to the paint mixed ready for spreading, or to the paint after it is dry? It is well known by those who have to do with painting that a coat of paint when freshly applied contains constituents which vaporize, and that consequently a dry coat of paint is not the same in its proportions as a coat of paint freshly applied. It has also been stated already that for paint ready to apply we regard linseed-oil or some equivalent material, japan and turpentine, as legitimate constituents. Of these by far the largest portion remains on the surface, but a good portion of the turpentine and some constituents of the oil pass off during the process of drying. The liquid portion of the paint which remains it is customary to call "binding material," and so far as our experience goes the binding material is always a little less than the liquid in the paint when it is applied. In some cases where very little japan is used the binding material is almost identical in amount with the liquid portion of the paint, since linseed-oil changes very little in weight, due to the drying process. The absorption of oxygen which takes place is about equivalent in amount to the losses of the oil during the drying. On the other hand, if a paint ready for spreading contains any japan, and this japan had in it any turpentine or benzine, the amount of the binding material left on the surface with the pigment would be somewhat less than the amount of the liquid in the paint. Since now all our experiments indicate that the greater the proportion of pigment in the paint the greater the durability, owing to the fact that the pigment apparently protects the oil from decay, we will state that in what follows in regard to proportions between pigment and liquid we refer to that portion of the liquid which stays with the pigment as "binding material." In other words, until we specially say to the contrary in the discussion that follows in regard to mixed paint, when we say pigment and liquid, we mean pigment and binding material. Our formulas for making mixed paint are based on this foundation. The material added for the purpose of making the paint spread well is a separate matter, and will be so treated.

Another preliminary question which it would perhaps be wise to discuss is, when we speak of proportions of pigment and liquid, do we mean proportions by weight or proportions by volume? We are well aware that the trade, and, in fact, practical master painters, are accus-

tomed to mix paints by taking so many pounds of pigment or paste and adding to it so many gallons or quarts or pints, as the case may be, of the liquid. This is all right so far as our knowledge goes, and there is no objection to this way of arriving at the result of getting a paint ready for spreading and a paint which will have great durability after it is dry, but it simplifies the discussion of the question very much, and we think places the matter on a philosophic basis to consider that the question of mixed paint is not by weights, but by volumes. Of course, with a little knowledge of the specific gravity of pigments and liquids, it is easy to pass from the weights to volumes or volumes to weights; or we may use a combination of volumes and weights in our practical formula; but we may as well state that our formulas are founded on proportions by volume. The reason for this is that paint, as we understand it, is a mechanical mixture of pigments with liquids, and when we say mechanical mixture we mean that there is no chemical combination between the pigment and the liquid and no solution of pigment in the liquid. They are simply mixed together, each one maintaining its own identity independent of the other. We are quite well aware that with white lead, red lead, and zinc white, and possibly several other pigments, there is a small amount of chemical action between the pigment and the liquid, but this is so small in amount that it can be allowed for, and does not really seriously interfere with the conception that a paint is a mechanical mixture of pigment and liquid. If we allow, then, that paint is a mechanical mixture, and that the proper proportions of pigment and liquid can best be obtained by volumes, it apparently places the mixing of paint on a philosophic basis, and gives us a chance to obtain some laws which are wide in their application.

How difficult it would be to get any uniform formula on which to proportion the pigment and liquid in paints, if the mixing is done by weights, will become evident from one or two examples. It is well known that seven or eight parts of white lead with two or three parts of boiled linseed-oil by weight make a paint ready foi spreading, and which will give very good results in service. If we attempt, however, to use the same formula—namely, seven or eight pounds of P. R. R. standard freight-car color, with two or three pounds of boiled linseed-oil, or raw linseed-oil, containing the proper amount of japan, we get a paint that is so thick that it cannot be spread at all with a brush, and indeed is so stiff a paste that it will hardly run out of the vessel. Clearly no uniform formula can be made use of to proportion pigment and liquid in paints if we attempt to do this by weight. On the other hand, our experiments indicate that proportions by volume apply fairly well to all pigments—that is to say, if all pigments were entirely devoid of chemical action between the pigment and liquid, and if all pigments were equally fine, we are inclined to think the same formula would apply for proportions of pigment and liquid, provided these proportions are decided by volume. We will give the figures of what we regard as the successful proportions by volume a little later.

(TO BE CONTINUED.)

Foreign Naval Notes.

THE Russian torpedo-cruiser *Kasarski* recently made a voyage from Pillau to Sebastopol, steaming in all 4,500 miles in 343 hours, at a mean speed of 12.28 knots. During part of the voyage she met with very heavy weather. This ship was built in Germany by Schichau; she is 190 ft. long, 24 ft. beam and has one triple-expansion engine, working up to 3,300 H.P. With natural draft the boat has a speed of 16 knots and with forced draft 21 knots an hour.

IT is stated that in consequence of troubles and break-downs experienced with the torpedo-chasers—vessels of about 400 tons displacement—in the last manœuvres of the French Navy, the locomotive boilers with which they are fitted will be taken out and replaced by tubulous boilers, probably of the d'Allest type.

EXPERIMENTS conducted on board the Italian armored ships *Castelfiardo* and *Ancona*, to test the suitability of petroleum fuel for use on shipboard, have resulted favorably. The apparatus used is an invention of Captain Cuniberti. It is claimed that petroleum is cheaper than coal, and that a battle-ship can keep the sea three times as long as is possible with coal. As a result of these experiments a course of instruction is to be opened on the *Ancona*, to make known the best method of procedure in firing with liquid fuel.—*Journal of the American Society of Naval Engineers.*

THE new Japanese cruiser *Hashidate Kan* was launched March 24 at the Imperial Dock Yard, Yokosuka. This ship is a fast unarmored cruiser of 4,300 displacement. She is 300 ft. long, 50 ft. beam, and 22 ft. average draft. The engines are of the triple-expansion type, and are expected to give a sea speed of 16 knots. The armament will be heavy for a vessel of this size. Some interest attaches to this ship, as she was built entirely by Japanese mechanics, and is the largest vessel yet built in that country. The steel from which she is constructed was bought in Europe.

Lake Transportation.

THE Sault Ste. Marie Canal officers are about to publish the results obtained from a discussion of the business of the canal during 1890, and it will be shown that the average cost per ton per mile on that part of lake freight that passed through the canal has again been reduced this time to 1.3 mills. Rates are steadily approaching the ocean figure, which is estimated at 1 mill per ton per mile. Following are some comparisons gained through advance information regarding the report:

	Freight tonnage, net.	Valuation of freight tonnage.	Average distance carried, miles.	Total cost, water transportation.	Cost per ton-mile.
1887	5,494,649	$79,031,758	811.4	$10,075,153	2.3 mills
1888	6,411,423	82,156,020	806.9	7,883,077	1.5 "
1889	7,516,022	83,732,527	790.4	8,634,246	1.5 "
1890	9,041,213	102,214,949	*707.2	9,472,214	1.3 "

The rates for different kinds of merchandise vary a great deal. In 1890 coal, which is an up freight, was carried for 0.5 mill per mile-ton, while miscellaneous merchandise cost 3.4 mills per mile-ton. Vessels made big profits in 1887, and this accounts for the high rates of freight.

The largest cargo passing the canal in 1890 was 3,021 tons, and was carried by one of the whaleback barges, No. 107.

The greatest number of mile-tons was reported by the steamship *Northern Queen*, one of the Great Northern Railroad boats.

The greatest aggregate number of tons carried through the canal by any vessel during the season was 77,124 tons by the steamship *Manola*, owned by the Minnesota Iron Company. This boat also reported the greatest number of miles run, 49,201 miles. In addition she made one trip to Escanaba, bringing her total season's run up to 50,580 miles in 223 days. It is believed that no boat ever before ran this distance in so short a time.

The total valuation of all vessels using the canal during the last four years is as follows:

1887 .... $19,773,950
1888 21,895,400
1889 26,926,200
1890 29,635,500

This shows that about $10,000,000 worth of vessel property has been added to the Lake Superior fleet within the past four years.—*Cleveland Marine Review.*

Water Power under Varying Heads.

THE Pelton Water-Wheel Company, of San Francisco, has contracted to remove the inward-discharge turbine water-wheels in the Columbian River Paper Mills, at La Camas, Washington, and replace them with Pelton wheels. One of the new wheels, only 5 ft. in diameter, is to develop 300 H.P., or, if required, 430 H.P., under a head of 110 ft. The small diameter is to adapt the speed to that of the main shaft, which runs at 141 revolutions per minute. Another wheel in the same mill is to run at 70 revolutions per minute and develope 50 H.P. Three other wheels are included in the contract. The two first named show the extreme flexibility of the system and itsadaptation to all the varying conditions of speed and power and head. This case shows the futility of tendering for pressure turbine wheels in the case of the Niagara Falls plant, where the head is 140 feet.—*Industry, San Francisco.*

* Mean 801.5.

THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.

(*Continued from page* 278.)

CHAPTER XI.—(*Continued.*)

PROLATE CYCLOID.

IF a tracing point o‴, fig. 270, be within the circumference of a generating circle *C*, a *prolate cycloid* will be described, when the circle rolls on the straight line A–A^{12}. This is the curve in which the center of the crank-pin of a locomotive moves when the wheel rolls on the rails.

PROBLEM 93. *To lay off a prolate cycloid.*

Let *C*, fig. 270, be the generating circle and o‴ the tracing point. Divide the circle into any number of equal parts, in

points in the curve, which may then be drawn as explained for other curves.

CURTATE CYCLOID.

If a tracing point, as *B* in fig. 271, is without the circumference of the generating circle *C*, a *curtate cycloid* will be produced terminating in *nodes* or loops *A* and *A* 12.

PROBLEM 94. *To lay off a curtate cycloid.*

Let *C*, fig. 271, be the generating circle. From *A* draw the director A–A^{12} equal in length to the circumference of the circle, and subdivide both into the same number of equal parts. With the distance from o″, the center of the generating circle to the tracing point *B*, draw another circle *D* from o″ as a center. This second circle should also be subdivided into the same number of equal parts as the generating circle beginning from the tracing point *B*. Erect perpendiculars from the points of division on the director and draw o″–12″, as in the preceding problem. From the points of intersection o″, 1″, 2″, 3″, etc., draw semicircles *b* B', *c* B^2, *d* B^3, etc. From *B*, the tracing point, draw chords B^1, B^2, B^3, etc. Take with

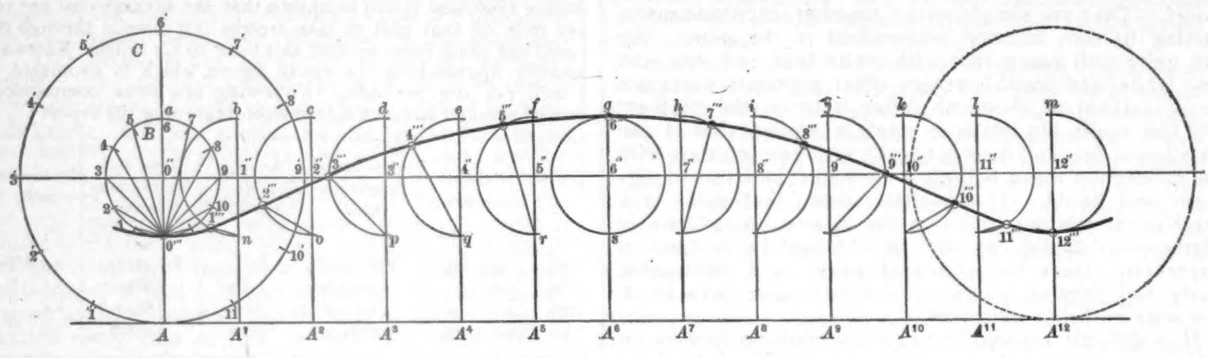


Fig. 270.

the present instance 12. From *A* draw the director A–A^{12}, whose length is equal to that of the circumference of the generating circle, and divide the director into the same number of equal parts into which the circumference of the circle is divided. Through the points of division draw perpendiculars *A a*, A^1 *b*, A^2 *c*, A^3 *d*, and through o″, the center of the generating circle, draw o″–12″ parallel to A–A^{12}. If o‴ is the tracing point, take a radius o″ o‴, equal to the distance of this point from the center of the generating circle, and with o″ for a center describe a circle *B*. Beginning from o‴ subdivide the small circle into the same number of equal parts as the large circle has been divided into, and from o‴ draw chords o‴ 1, o‴ 2, o‴ 3, etc., to the points of division. From the points of intersection, 1″, 2″, 3″, etc., of the perpendiculars with the line o″–12″, as centers, and o″ o‴ as a radius draw semicircles *b n*, *c o*, *d p*, *e q*, etc., in pencil. Then take with a pair of

dividers the length of the chord B^1 and set it off from B^1 to 1‴, which will be a point in the curve. In the same way take the chord B^2 and set it off from B^2 to 2‴, which will be another point. Continue in this way and set off the respective curves from B^3, B^4, B^5, etc., and then draw the curve through these points.

SPIRAL.

A spiral is a curve described by a point which revolves around a center, and either recedes from or approaches the center as it revolves.

PROBLEM 95. *To construct a spiral of one revolution around its center.*

Let *A*, fig. 272, be the center. From this with the widest limit, *A* 12, as a radius, describe a circle 1, 2, 3–12. Divide the

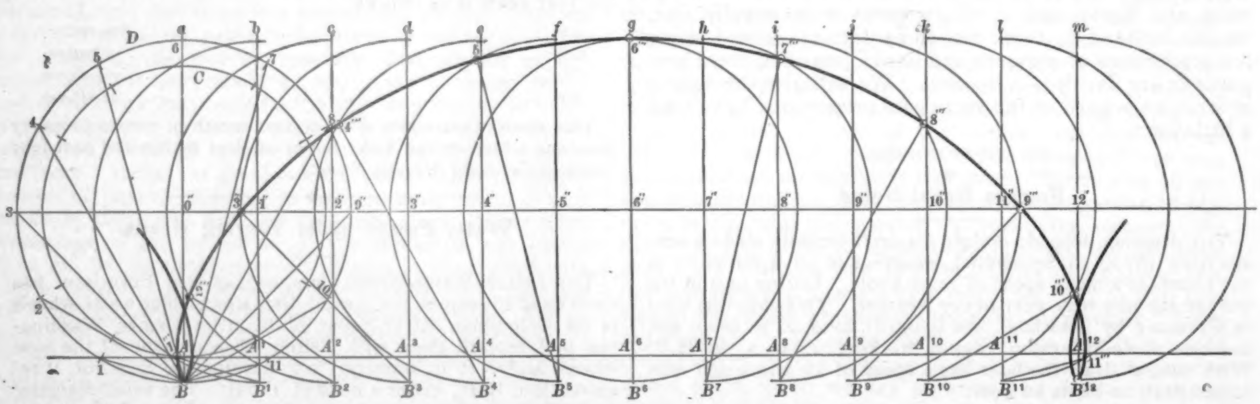


Fig. 271.

dividers the chord o‴ 1 and set it off from *n*—the intersection of the semicircle *b* with the perpendicular 1″ A^1—to 1‴, this will be a point in the required curve. Then take with the dividers the chord o‴ 2 and set off from *o* to 2‴; then 2‴ will be a second point in the curve. Set off the chord o‴ 3 from *p*, and so on successively lay off the chords o‴ 4, o‴ 5, o‴ 6, etc., from *q*, *r*, *s*, etc., on the small circles; then 4‴, 5‴, 6‴, etc., will be

circle into any number of equal parts, as 1 to 12, and draw radii from the points of division to the center *A*. Divide one of these radii, as 12 *A*, into a corresponding number of equal parts, 1′, 2′, 3′–12. From the center *A*, with a radius *A* 1′, describe an arc cutting the radius 1 in *a*; then *a* will be a point in the curve. With a radius *A* 2′ describe an arc cutting radius 2 in *b*, which will be another point in the curve. From the

center A continue to describe arcs with radii $A\ 3'$, $A\ 4'$, $A\ 5'$, etc., cutting the corresponding radii 3, 4, 5, etc., in the points c, d, e, etc. These will be points in the curve, which can then be drawn through them.

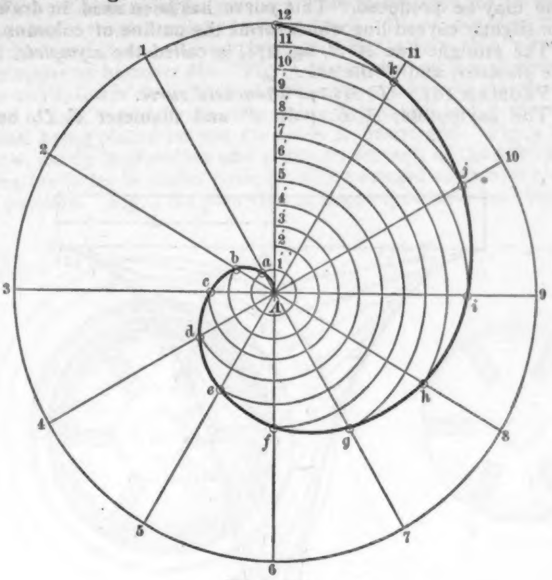


Fig. 272.

It is plain that a spiral of any number of revolutions around its center may be drawn by continuing it outside of the circle 1, 2, 3–12, by the method described.*

PROBLEM 96. *To draw an approximate or false spiral.*

Lay off a central square $a\ b\ c\ d$, fig. 273. Then from d as a center and $d\ A$ as a radius draw the arc $A\ e$. Next with $a\ e$ as a radius and a as a center draw $e\ f$. Again, with $b\ f$ as a radius and b as a center draw $f\ g$, and with $c\ g$ as a radius and c as a center draw $g\ h$. Continue in this way until the required number of revolutions of the spiral are completed.

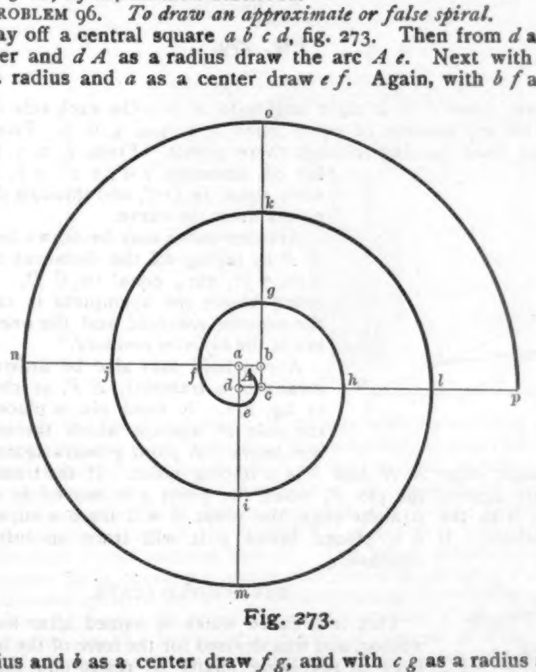


Fig. 273.

THE INVOLUTE.

If a string is wound around a cylinder, A, fig. 274, and a tracing point o is attached to the free end of the string, it will describe a curve which is called the *involute* of a circle.

PROBLEM 97. *To construct an involute of a circle.*

Let A, fig. 274, be the circle. Divide it into any number of equal parts—12 in the engraving—and draw radii from the points of division to the center A. From the extremities of these radii draw lines, as 1 1′, 2 2′, 3 3′, etc., perpendicular to the radii and tangent to the circle. Find the circumference of the circle and take one-twelfth of it in a pair of dividers, and set it off on the tangent line from 1 to 1′; then will 1′ be a point in the curve. Set off twice this distance from 2 to 2′, and 2′ will be another point. Continue in this way and set off successively on the tangent lines the number of parts corresponding to the number of the radius; then will 1′, 2′, 3′, 4′–12′ be points in the curve.

* This figure and much of the elucidation of this problem have been taken from Ellis A. Davidson's "Linear Drawing."

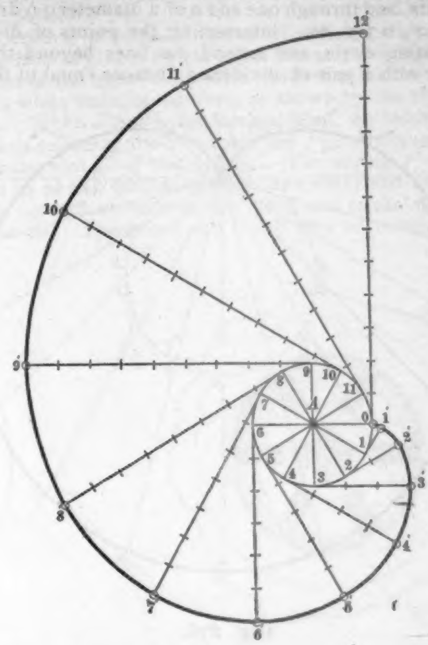


Fig. 274.

SPIRAL CAM.

Fig. 275 represents a cam whose outline is formed of two spirals. It possesses the property of giving a reciprocating piece of machinery a uniform motion.

PROBLEM 98. *To lay out a spiral cam.*

Let $A\ C\ B$, fig. 275, represent the hub or boss of the cam and $C\ D$ its stroke. First divide the circle $A\ C\ B$ into 12 equal parts, and draw radial lines through the points of division and the center, and extend them outside of $A\ C\ B$. Next divide the stroke $C\ D$ into six equal parts. Suppose the curve begins at o and the reciprocating piece touches the cam at that point, then, with such a cam, the purpose is that the reciprocating piece shall be moved one-sixth of the stroke $C\ D$, while the cam turns one-twelfth of a revolution. Therefore, from the center E with a radius E 1 draw an arc of a circle through 1 and cutting the radial line 1′. The point of intersection 1′ will then be a point in the curve. In a similar way draw arcs of circles through 2, 3, 4, and 5, intersecting the radial lines 2′, 3′, 4′, and 5′. The outline of the cam may then be drawn through these points.

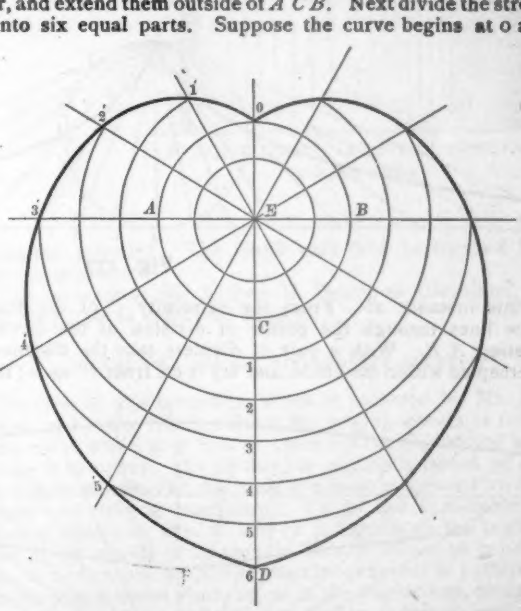


Fig. 275.

THE CARDIOID.

This curve may also be used for the outline of a cam.

PROBLEM 99. *To lay out a cardioid curve.*

Let *A B*, fig. 276, be the generating circle. Subdivide this into, say, 12 parts, and through one end 0 of a diameter 0 6 draw lines 0 1 1′, 0 2 2′, 0 3 3′, etc., intersecting the points of division of the generating circle, and extend the lines beyond the circle. Then take with a pair of dividers a distance equal to the diameter 0 6, and from the point of division 1 in the generating circle lay off this distance, 1 1′ and 1 1″, on each side of 1. The points thus laid off will be in the curve. Proceed in a similar way and lay off from 2, 3, 4, etc., distances 2 2′, 2 2″, 3 3′, 3 3″, etc., which will give points in the curve through which it may be drawn.

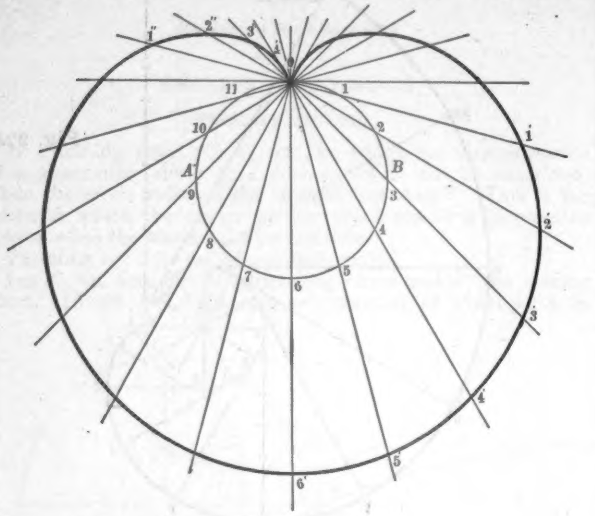


Fig. 276.

THE CISSOID.

PROBLEM 100. *To lay out a cissoid curve.*

Draw any line *A B*, fig. 277, and *C D* perpendicular to it. On *C D* describe a circle and divide it into a number of parts, in this instance 16. From the extremity *C* of the diameter draw lines through the points of division of the circle and meeting *A B*. With a pair of dividers take the distance *C* 1, intercepted within the circle, and lay it off from 1″ to 1′; then 1′ will be a point in the curve. Similarly take *C* 2 and lay it off from 2″ to 2′, and 2′ will be another point. Proceed in this way with the other lines drawn through *C* and the divisions of the circle, which will give points through which the curve can be drawn.

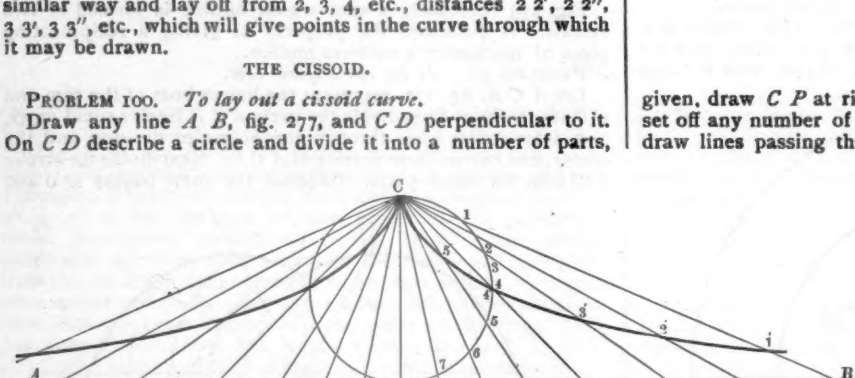


Fig. 277.

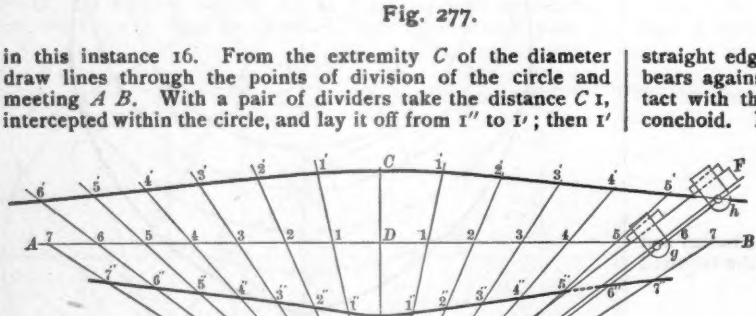


Fig. 278.

CONCHOID CURVE.

The *conchoid* is a curve which always approaches a straight line, but never reaches it, however far the curve and straight line may be produced. This curve has been used in drawing the slightly curved line which forms the outline of columns.

The straight line *A B*, fig. 278, is called the *asymptote*, *C D* the *diameter*, and *P* the *pole*.

PROBLEM 101. *To lay out a conchoid curve.*

The asymptote, *A B*, pole *P* and diameter *C D*, being given, draw *C P* at right angles to *A B*. On each side of *D* set off any number of equal parts, 1, 2, 3, 4, 5, 6, 7. From *P* draw lines passing through these points. From 1, 2, 3, etc., lay off distances 1 1′, 2 2′, 3 3′, etc., each equal to *D C*, and through these points draw the curve.

Another curve may be drawn below *A B* by laying off the distances 1 1″, 2 2″, 3 3″, etc., equal to *C D*. The curve above the asymptote is called the *superior conchoid*, and the one below it the *inferior conchoid*.*

A conchoid may also be drawn by means of a trammel, *E F*, as shown in fig. 278. A fixed pin is placed at the pole *P*, against which the trammel bears. A point *g* bears against a straight edge *A B*, and *h* is a tracing point. If the trammel bears against the pin *P*, while the point *g* is moved in contact with the straight edge, the point *h* will trace a superior conchoid. If *h* is placed below *g* it will trace an inferior conchoid.

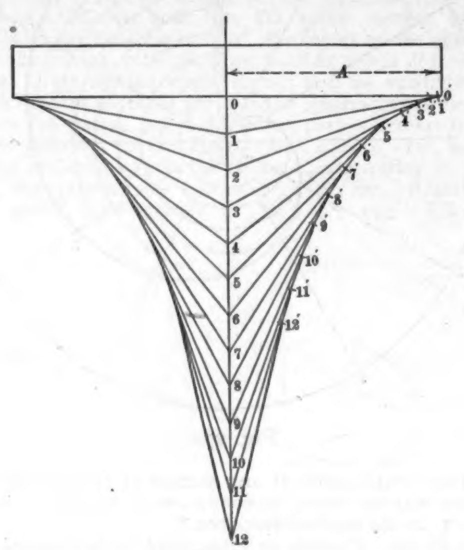


Fig. 279.

THE SCHIELE CURVE.

This is a curve which is named after its inventor, and was devised for the form of the bearings of revolving shafts to resist end thrust. Its object is to form a bearing which will wear uniformly.

PROBLEM 102. *To lay out a Schiele curve.*

After the dimension *A*, fig. 279, or half the largest diameter of the bearing is determined, divide the axis 0–12 into any number of equal spaces, 0 1, 1 2, 2 3, etc. Then set compasses to the dimension *A*, and from the point 1 describe an arc cutting 0 0′ at 1′, and draw a line 1 1′ through the point of intersection 1′. Then from 2 as a center, with a radius *A* describe an arc cutting 1 1′ at 2′, and again draw a line 2 2′ through the point of intersection. Continue in this way intersecting the preceding lines from the successive centers 3, 4, 5, etc., and the points 1′, 2′, 3′–12′ will be points in the curve.

(TO BE CONTINUED.)

* From Ellis A. Davidson's "Linear Drawing."

Recent Patents.

BEACH'S MACHINERY FOR FORMING CAR WHEELS.

THE accompanying engravings show machinery for forming car wheels from wrought iron or steel. Fig. 1 is a plan view of the anvil, lower die and ejector. Fig. 2 is a plan view of the upper or hammer die. Fig. 3 is a central sectional view of the anvil, lower die, ejector and hammer, taken on the dotted line of figs. 1 and 2, the dies being separated and a piece of metal being placed on the die ready to be swaged. Fig. 4 is a view, partly in elevation and partly in section, of the anvil and dies, the latter in closed position, with a swaged car-wheel blank in position. Fig. 5 is a plan view of the swaged car-wheel blank.

Fig. 1.

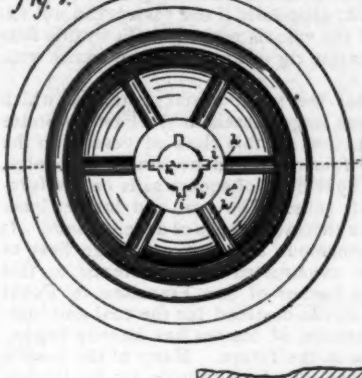


Fig. 2.

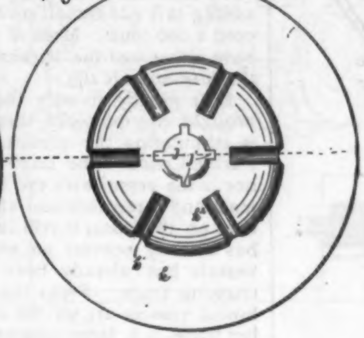


Fig 3.

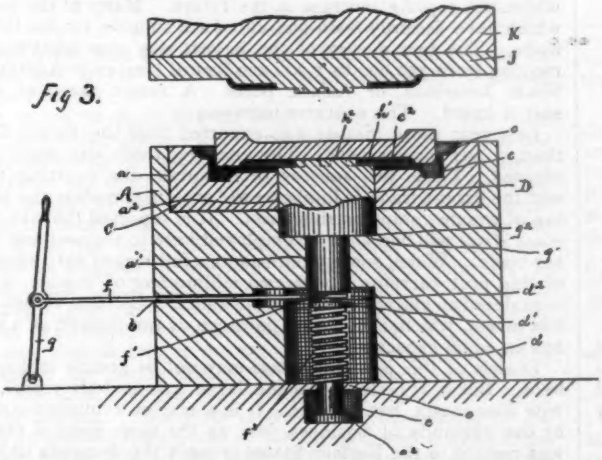


Fig 5.

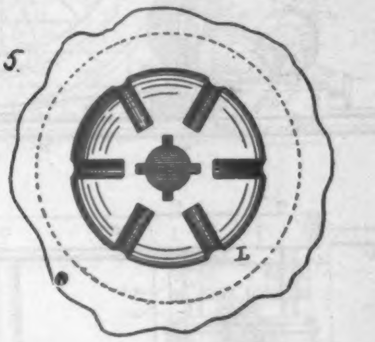


Fig. 4.

BEACH'S MACHINERY FOR FORGING CAR-WHEELS.

A is the anvil, provided on its face with die-opening a with vertical opening a', extending downwardly through the anvil. Horizontal opening b extends from said vertical opening to the periphery of the anvil. Anvil-die C fits in said die-opening, and is provided with vertical opening a^2. Fitting in the latter opening is ejector D, the standard d of which is provided with shoulder d' and annular slot d^2. The lower extremity of said ejector fits in opening e, and is provided with shoulder e^2, adapted to engage with floor e'. Extending through horizontal opening b is rod f, having its inner bifurcated extremity f' engaging with annular slot d^2. Its outer extremity is pivoted to lever g, that is in turn pivoted to the mill-floor. Coil-spring f^2 surrounds said standard and has engagement at its upper extremity against shoulder d' and at its lower extremity on the mill-floor. Annular shoulder g' of the ejector has solid bearing when in lowered position against the annular shoulder g^2 of the vertical opening a^2.

Anvil-die C has its face formed in several elevations, annular groove c being most deeply depressed. In this the tread of the wheel is formed. In the next outer depression or annular groove c' the flange portion of the wheel is formed. An annular projected web-forming portion c^2 is raised in relative relief above groove c and surrounds or incloses the central projected disk portion h^2 and also face h'. This web-forming portion is provided with a series of radial grooves, h, which are in depth intermediate of the groove portions c and the web-forming portion c^2. The face h' of the ejector forms a part of this die and is flush with the web-forming portion of the same. Said face is provided with the projected portion h^2 and the four projected lug portions i. Corresponding disk and lug portions $j\,j'$ are respectively formed on the face of the hammer-die J, that is, attached to hammer K. Said disk and lug portions register with the corresponding parts on the anvil-die. Said hammer-die is further provided with the flat annular portion k, the radial rib-forming groove or depressed portion k' and the projected web-forming portion k^2.

In operation a piece of metal of suitable size and of soft swaging-heat is placed on the lower die and thoroughly swaged by means of the upper die until it conforms to the form of the two dies when brought together, as shown by the blank L, figs. 4 and 5. When the swaging is completed, the lever g is drawn back, thus releasing the bifurcated rod f from engagement with the annular slot d^2 of the ejector. The spring f^2 is then free to exert its power, forcing upward the ejector and carrying with it in its upward movement the blank and releasing said blank from the die. Thereupon the blank may be removed and the operation repeated. The blank may then be finished in any suitable manner.

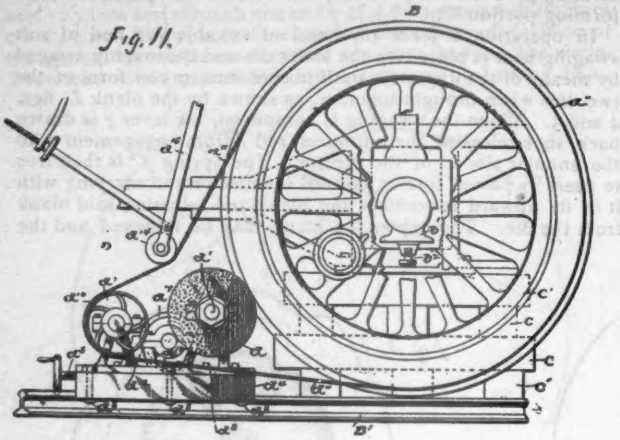
The inventor is Mr. Clifton B. Beach, of Cleveland, Ohio, and his patent is numbered 445,238.

MEANS FOR TRUING LOCOMOTIVE WHEELS.

The aim of this invention, which is patented by Mr. Joseph Elder, of Peoria, Ill., is to true the driving-wheels or tires of a locomotive while they are in place on the engine and without taking it to a shop. To do this the engine is raised up so that its wheels are clear of the track and may be rotated by its own steam and driving machinery. To do this a portable emery grinder, shown in figs. 11 and 12, is placed on the track adjacent to the wheels to be trued. This is driven by belts $d''\ d''$, figs. 11 and 12, on the driving-wheels connected to pulleys either on the emery-wheel shaft, or, as in the engravings, to speeding gear; $d\ d$ are emery wheels attached to a shaft d', and with its gearing it is mounted on a frame or bed-plate which rests on the rails and is attached to them with clip-bolts. The gearing is mounted on a slide rest which is moved by an adjusting screw d^5 by which the grinder can be brought up in contact with the tread of the wheel. The grinder-shaft d' is provided with a grooved friction-pulley d^6, by which it receives motion through an idler d^7 from a driving-pulley d^8. The idler and driving-pulley are mounted on shafts in bearings on the plate d^9, and the shaft of the driving-pulley is provided with a band-pulley d^{10}, driven by a belt d^{11}, passing around the driving-wheel of the engine, so that when the latter is rotated it drives the grinder in contact with its surface. The idler-shaft is mounted in vertically-sliding bearings d^{10}, sustained by adjusting-screws d^{12}, to produce the required degree of friction be-

tween the pulley-surfaces. A belt-tightener d^{14}, mounted on lever d^{15}, or otherwise sustained, may be used, if required.

Fig. 11.



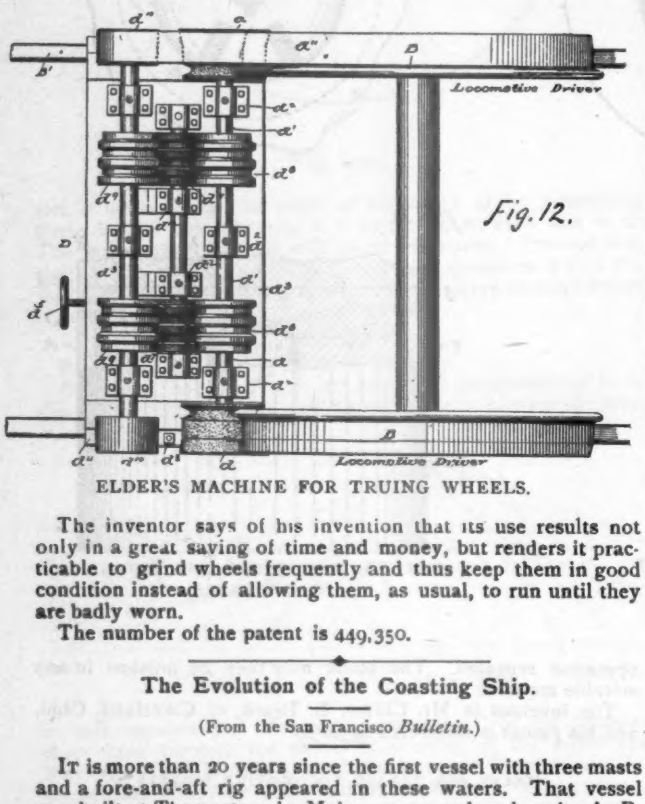


Fig. 12.

ELDER'S MACHINE FOR TRUING WHEELS.

The inventor says of his invention that its use results not only in a great saving of time and money, but renders it practicable to grind wheels frequently and thus keep them in good condition instead of allowing them, as usual, to run until they are badly worn.

The number of the patent is 449,350.

The Evolution of the Coasting Ship.

(From the San Francisco *Bulletin*.)

It is more than 20 years since the first vessel with three masts and a fore-and-aft rig appeared in these waters. That vessel was built at Thomaston, in Maine, on an order given by A. P. Jordan, of Santa Cruz, then of the firm of Davis & Jordan, lime manufacturers and merchants. The vessel took the name of the junior partner. This was a small craft, a little under 400 tons, with flat floors and large carrying capacity. Except the extra mast there was no novelty about the vessel. She was employed for many years in the lumber and coal trade on the coast, and occasionally made a foreign voyage.

The Maine shipbuilders had begun to build large fore-and-afters. Those vessels became popular in the lumber, cotton and coal trade. They were mostly designed as coasters. The capacity was gradually increased, until vessels with this rig were constructed that would carry from 800 to 1,000 tons. That was supposed to be about the limit of a fore-and-after. Then the Maine shipbuilders added another mast and increased the tonnage. Some of the largest of these four-masters would carry as much as 1,500 tons. They were found to be profitable vessels, or the number would not have rapidly increased. In one small town in Maine last year, four vessels of this class were built. The carrying capacity has been gradually increased until the largest four-masters can carry about 2,000 tons.

The appearance of a five-master in this port with a carrying capacity of about 3,000 tons, on about half the registered tonnage, has attracted a great deal of attention as a sort of marine curiosity. It was assumed that this was the first five-master with a fore-and-aft rig that ever appeared in this port. But two years ago or more the Simpson Brothers, of this city, who are largely engaged in the lumber trade on this coast, built a five-master at Coos Bay. That was the *first* vessel ever seen in this port with five masts and a fore-and-aft rig. It was an odd-looking craft, and on her first appearance attracted much attention. The vessel carried no gaff-topsails, her masts were composed of a single stick; all the sails were handled from the deck. This vessel carried about two tons dead weight for each registered ton. She is not as large as the *Governor Ames*. Every few days the former vessel appears in port with a cargo of coal or lumber. The reports of her work here have always been favorable. She is an easy vessel at sea, a good sailer and a large carrier. As the Simpson Brothers, who launch several vessels every year, have not added another five-master to their fleet, the inference is that no particular advantage was found in adding this additional stick, especially if the vessels did not exceed 1,000 tons. Most of the vessels recently built by this firm have either had the barkentine rig or have had four masts with the fore-and-aft rig.

It is worthy of note that the same business in kind which brought into existence these large vessels in the Eastern States is stimulating the construction of this class of vessels on the Pacific Coast. The large four-master is no longer a novelty, nor is the vessel with the hybrid rig of square sails on the foremast and three fore-and-aft sails. The coal and lumber business on this coast is still in the early stages of development. It has already become an enormous business. A large fleet of vessels has already been constructed with reference to this coasting trade. From the harbor of San Francisco to Puget Sound vessels are on the stocks destined for the coal and lumber trade. A large exportation of lumber has already begun, which will rapidly increase in the future. Many of the vessels which have recently been put afloat are suitable for the foreign trade. The four-master of the largest size now takes a cargo ranging from 750,000 to 1,000,000 feet of lumber to Australian, South American, or Asiatic ports. A return cargo of some sort is found. The ventures increase.

Last year more lumber was exported from the Pacific Coast than in any former year. The coasting trade also rapidly increased. These two sources of business—the coasting trade and the export trade in lumber—will greatly stimulate the building of wooden ships on this coast. It is reported that the *Governor Ames* will hereafter be employed here in the coal and lumber trade. When, some months ago, a full-rigged ship went out of this port carrying about two million feet of lumber, it was considered an extraordinary circumstance. But this vessel with five masts, which, in common parlance, is not classed as a ship, has an equal capacity.

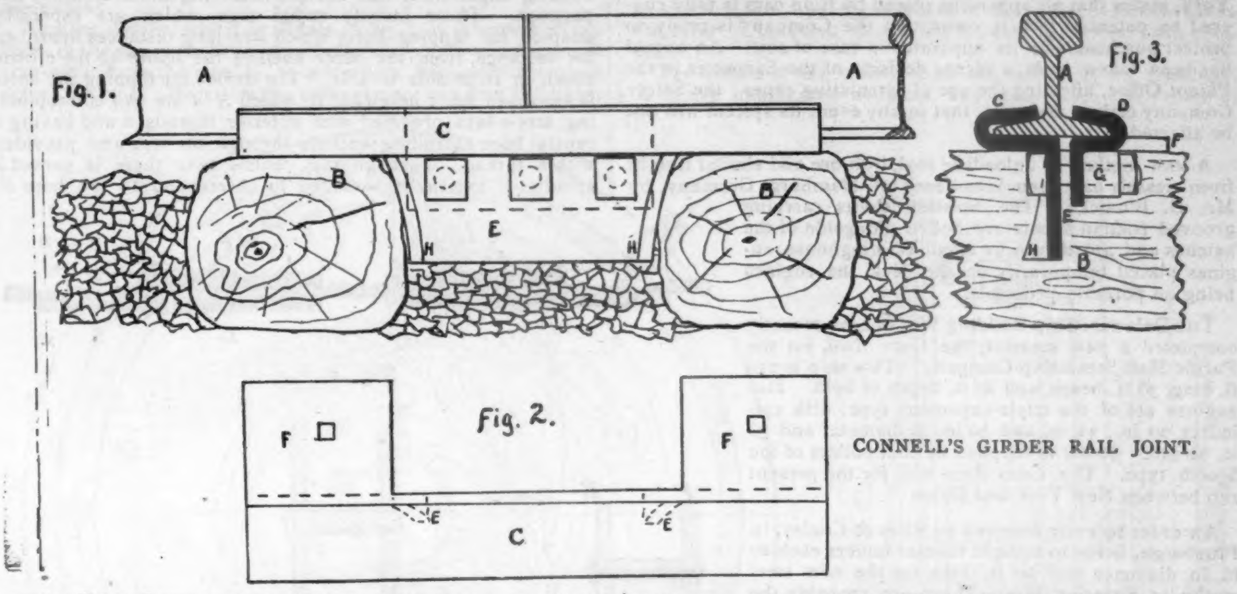
Vessels of this particular class may not be greatly multiplied here. But it is certain that the large fore-and-aft vessel, say with four masts, has the call. It is a marine evolution created by the demands of business, just as the same class of vessels was created in the Eastern States to meet the demands of business up and down the Atlantic Coast. This evolution is also, to some extent, a solution of the problem. How can the largest amount of dead weight or the largest number of feet of lumber be carried on long or short voyages at the smallest possible cost? At one time it was thought that the steam schooner was about to settle the question. But the evolution now is in the direction of the great fore-and-after, with a forest of masts and no auxiliary power.

Connell's Girder Rail Joint.

The joint, which is shown in the accompanying illustrations, is intended to serve not only as a connection for the rails, but to furnish a support underneath the joint, which will prevent any sagging of the ends of the rails, and will give the joint a carrying power equal to any other portion of the rails. Fig. 1 is a side view of the joint, fig. 2 a cross-section, and fig. 3 a plan of the main plate, showing the manner in which it is made to serve as a tie-plate, as well as a joint.

This main plate or member of the joint is proportioned in its sectional area to carry between the ties the heaviest driving-wheel load, with an allowance added for the effect of impact, the calculation being made with the unit stresses used in bridge construction, and without depending upon the projecting rail-ends for the support of any portion of the load. It will be seen that it is so arranged that the flange or carrying part *E E* is in line, and practically continuous with the web of the rail *A*. This carrier is a steel plate bent down in the shape shown in figs. 1 and 2, and deriving additional stiffness from the flanges at each end of the vertical portion, which also serve to give it an additional bearing on the ties. At each end of the

plate is a projection, *F*, which serves as a tie-plate, and through which a spike can be driven to prevent all movement of the rail. The second plate *D*, which is called the liner, is placed on the inside of the rail, bringing the nuts of the joint-bolts inside the track, where they can be conveniently inspected and tightened, if necessary, by the trackman. It will be seen that the bolts come underneath the rail, and that by means of the



CONNELL'S GIRDER RAIL JOINT.

washers *G* the nuts are brought out where they can easily be reached, and where the trackmen can apply their wrenches without difficulty.

The entire joint, it will be seen, consists of the two steel plates and three bolts. The bolts being placed beneath the rail, no punching or drilling of the web of the rail is required, nor is there any notching of the rail flanges. It can be applied to any weight of rail from 56 lbs. upward, with a minimum change in construction, the only variable feature being the angle which the top of the rail-flange makes with the base. The inside member of the joint *D* makes and maintains the line of track. It is claimed for this joint, in addition to the advantages pointed out above, that it gives a large bearing surface, will resist wear, will keep the track in good surface, and also that in it the force which ordinarily produces creeping of the rail is utilized to increase the connection between the joint and the rail, by means of the camber put in the carrier-plate. This force is resisted by the bearing of the carrier on the rail-flange, and of the flanged web *E* against the cross-tie. The cost of the joint will not exceed that of the ordinary double angle-joint now used.

This joint is protected by patent No. 451,554, recently granted to the inventor, Mr. W. H. Connell, whose address is Wilmington, Del.

Manufactures.

General Notes.

ONE of the largest manufacturers of elevators in this country, located in Baltimore, Md., states that his firm has been using Dixon's graphite grease on elevators for the past two years and finds it superior to any lubricant before used for that purpose. They also use it on wire cables to prevent rust and on elevator guides.

IT is understood that a large steel plant is to be put up shortly at Ensley, Ala., by the Tennessee Coal, Iron & Railroad Company. The objection has always been made to Southern iron that it is not adapted to the Bessemer process, but at Ensley the Basic process is to be used.

RIEHLE BROTHERS, in Philadelphia, have recently received orders for a 10,000-lbs. iron tester for the Benedict & Burnham Company, Waterbury, Conn.; a 5,000-lbs. transverse tester for the New York Car-Wheel Works, Buffalo, N. Y.; a 3,000-lbs. transverse tester for the Albion Iron Works, Victoria, B. C.; a 2,000-lbs. cement tester for the City Engineer, Los Angeles, Cal., and a 1,000-lbs. cement tester for Paige, Carey & Company, Wheeling, W. Va. The Company has also recently sold a number of the Robie patent screw-jacks of 10 and 20 tons capacity to different parties, including Meyer & Company, Norfolk, Va.; W. G. B. Fitzgerald, Norfolk, Va.; Jones & Laughlin, Pittsburgh; Valk & Murdock, Charleston, S. C.; Worth Brothers, Coatesville, Pa.; Pulaski Development Company, Pulaski, Va.; Max Meadows Iron Company, Max Meadows, Va.; E. O. Norton, Binnewater, N. Y.; Lombard & Company, Augusta, Ga.; Weston Furnace Company, Manistique, Mich.

AT the annual meeting of the Consolidated Car Heating Company in Albany, N. Y., recently, the following officers were chosen for the ensuing year: President, Robert C. Pruyn, Albany; Vice-President and Treasurer, William G. Rice, Albany; General Manager, D. D. Sewall, New York; Mechanical Superintendent, James F. McElroy; Assistant General Manager, J. H. Sewall, Chicago; Secretary, Charles J. Peabody, Albany; Executive Committee, Robert C. Pruyn, William G. Rice, George Westinghouse, Jr., D. D. Sewall, James F. McElroy, and A. S. Hatch.

THE plan of carrying a lighting and heating tender on passenger trains devised by Mr. George Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul, has been heretofore described. This tender carries a boiler which furnishes steam to heat the train and to run the dynamo engine. For this service Mr. Gibbs made experiments with several types of engines, but without satisfactory results in the main particulars. With one form of horizontal engine it was found impossible to avoid an irritating vibration which was transmitted throughout the entire length of the connected train. The adoption of the Westinghouse engine proved successful in every particular. The same Company is using a 50-H.P. single-acting compound engine in its lighting plant at the passenger station in Milwaukee.

THE Buffalo Railway Supply Company has removed its offices to No. 52 Exchange Street, Buffalo, N. Y.

IT is claimed that the largest carrier on the lakes is the steel steamer *E. C. Pope*, built by the Detroit Dry Dock Company. She has just delivered a load of 3,070 net tons from Lake Superior on 14 ft. 1 in. draft; on 16 ft. draft she will carry 3,800 tons. The *E. C. Pope* is 337 ft. long over all, 42 ft. beam, and 24 ft. depth of hold.

THE American Steel Barge Company is extending its operations to the Atlantic. The steam whale-back barge *A. D. Thompson*, which was launched at West Superior, Wis., June 6, is the thirteenth of these barges now afloat. She has triple-expansion engines built in England, and is almost a duplicate of the *Charles W. Wetmore*, which has just left the head of Lake Superior for the Atlantic. The *Wetmore* will go direct to England with wheat. Her cargo of 70,000 or 80,000 bushels will be increased to about 100,000 bushels after the boat takes it on a second time at Montreal, it being necessary to go down the St. Lawrence rapids light. The *Wetmore* will probably go down the rapids in company with the *Colby* and her tow barge, as the latter is now delayed at Kingston for repairs to her boiler. The *Colby* and tow will engage in the Atlantic coast

trade for the present, and may be sent around the horn to the Pacific in the fall. These barges are 265 ft. long, 38 ft. beam, and 24 ft. deep, and their dimensions are of interest, as they show the largest boat that can reach the Atlantic from the lakes by going through the locks of the Welland and running the rapids of the St. Lawrence.—*Cleveland Marine Review.*

THE Safety Car Heating & Lighting Company, of New York, states that all apparatus placed by it on cars is fully covered by patents which it owns, and the Company is ready to protect purchasers of its apparatus in case of suit. An appeal has been taken from a recent decision of the Examiner in the Patent Office, affecting the use of circulating pipes; the Safety Company claims, however, that in any event its system will not be affected.

A NEW method of unloading coal, iron ore and similar freight from vessels has been introduced at Hamburg, Germany, by Mr. G. Blumcke. The hoisting shafts carrying grooved friction spools are bolted alongside of the hatches and are driven by small Westinghouse engines placed temporarily on the deck, the engines being on portable pedestals.

THE Delaware Ship Building Works have recently completed a new steamer, the *Costa Rica*, for the Pacific Mail Steamship Company. This ship is 250 ft. long, 36 ft. beam, and 20 ft. depth of hold. Her engines are of the triple-expansion type, with cylinders 20 in., 32 in. and 50 in. in diameter and 36 in. stroke. Steam is supplied by four boilers of the Scotch type. The *Costa Rica* will for the present run between New York and Colon.

AN order recently received by Riter & Conley, in Pittsburgh, is for 10 upright tubular boilers each 10 ft. in diameter and 30 ft. high for the new steel works at Superior, Wis. These are probably the largest boilers of this class ever built.

THE McConway & Torley Company, in Pittsburgh, is enlarging its office, requiring additional room. This Company recently shipped to one party 10 car loads of Janney couplers.

THE largest pair of rolls ever made in Pittsburgh were recently completed at the Phœnix Works in that city. They are 25 ft. 5 in. in length and 24 in. in diameter, and are intended for a plate-bending machine at the Mare Island Navy Yard.

IT is stated that the Lafayette Car Works, Lafayette, Ind., will be removed to Lima, O., and consolidated with the car works there under the name of the Ohio Car Company.

THE Southern Pacific Company is altering one of its consolidation engines to a compound engine. The engine, which was built at Schenectady two years ago, will be converted into a two-cylinder compound provided with the Pitkin intercepting valve. The cylinders will be 20 and 26 in. in diameter by 26 in. stroke. The driving-wheels are 56 in. in diameter and the engine weighs 133,000 lbs.

THE Harlan & Hollingsworth Company have recently completed a new steamboat, the *Montauk*, for the line between New York and Sag Harbor. The *Montauk* is 175 ft. long and 31 ft. beam and 11 ft. depth of hold. She has a surface condensing beam engine with cylinders 38 in. in diameter and 9 ft. stroke, with Stevens cut-off and proportioned to carry a working pressure of 60 lbs. The paddle wheels are iron feathering wheels 20 ft. 6 in. in diameter and 8 ft. face.

Norfolk Improvements.

THE Norfolk & Western Railroad is now building in Norfolk, Va., a new passenger station and freight house, which will cost about $250,000. The Company is also completing its belt line around the city, and is building an engine-house and repair shop at Lambert's Point. In connection with this belt line the docks at Lambert's Point are to be extended and a large grain elevator is to be put up there. It is also expected that a special dock will be built there for unloading Cuban ores, which will be transported over this road, and used in some of the furnaces along the line for mixing with West Virginia and Virginia ores for the manufacture of Bessemer pig iron.

Boilers and Stay-Bolts.

IN shops for the construction and repair of locomotives, it is well known that in many instances the most troublesome jobs in hand are the drilling and tapping of stay-bolt holes and the removal and replacing of old and broken stay-bolts. Having this in view, Mr. J. T. Connelly, of Milton, Pa., a boiler-maker of long experience, has devised some ingenious tools for this purpose. These include radial taps, which are especially adapted for tapping holes which are long distances apart, as, for instance, from the outer shell of the boiler to the crown-sheet, or from side to side. The device for tapping the holes is shown in fig. 1 herewith, in which *A A* are two corresponding screw-taps provided with exterior threads *a* and having a central bore extending entirely through the taps and provided with a thread. Through this central bore there is passed a spindle *C*, externally threaded to correspond to the bore *B*.

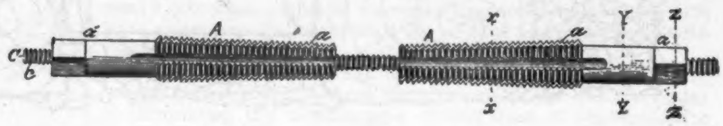


Fig. 1.

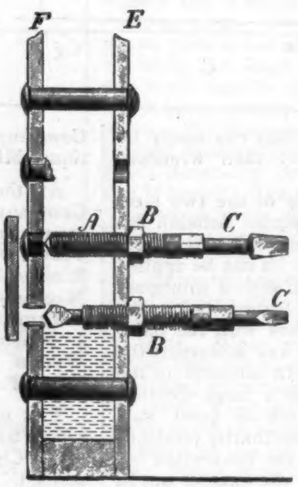


Fig. 2.

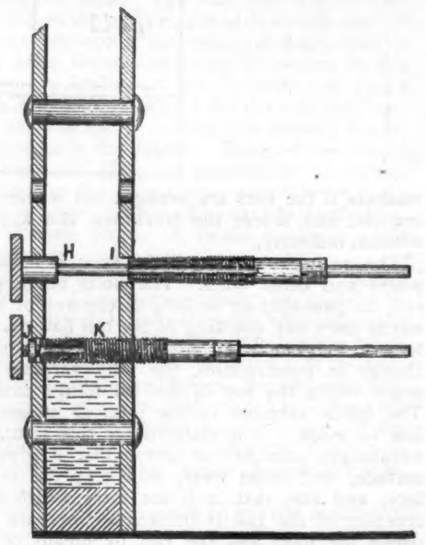


Fig. 3.

CONNELLY'S STAY-BOLT DRILLS AND RADIAL TAPS.

This spindle may be of any desired length, and the screw taps *A A* are mounted upon it, as shown, being thus adapted to work toward each other and to be guided by the spindle in a straight line. In operation this may be used by two men at the same time, one working from the inside and the other from the outside. One tap is secured upon the spindle far enough to have a firm bearing, and the spindle *C* is then passed through the holes to be threaded until the end of the tap enters the adjoining sheet, and the other end extends or projects far enough from the hole in the other sheet to receive the other tap, which is then secured upon the projecting end of the spindle; the taps are run into the respective sheets and the bolt holes are threaded. The great advantage of this arrangement is that the taps are guided in a perfectly straight line, even where the holes are long distances apart, and the threads cut in both sheets correspond.

The second device is for drilling out or removing old or broken stay-bolts without displacing any parts of the engine, and is best shown in operation, as in fig. 2. Here there is used an externally threaded tubular guide *A* which is screwed into the thread of the old stay-bolt hole of the fire-box sheet, and made to approach the part of the bolt in the outer sheet. The portion of the broken bolt in the fire-box sheet can be readily removed in the usual way, as it is always accessible from the inside. The guide *A* will approach the portion of the bolt in the outer sheet in a straight line, as its direction will be determined by the thread in the inside sheet. When it has been screwed in far enough, or so as to approach the broken bolt end, it can be locked in position by the jam-nut *B*. The drill *C* is then passed through the guide and may be readily driven

to accurately drill out or remove the bolt. In case a drill with a larger point, which will drill out the full-size hole, is preferred, the drill stem may be passed through from the front end of the nut *B*. This arrangement is shown in the lower hole in fig. 2. It will be seen that even where the stay-bolts which are broken come inside the frames or other portions of the engine, no part will have to be moved as long as the inside of the fire-box is accessible.

Another device, which is shown in fig. 3, is intended to tap holes in the plates of locomotive boilers at points which are not accessible from the outside, a case which frequently occurs in actual practice. Here also the arrangement can best be shown

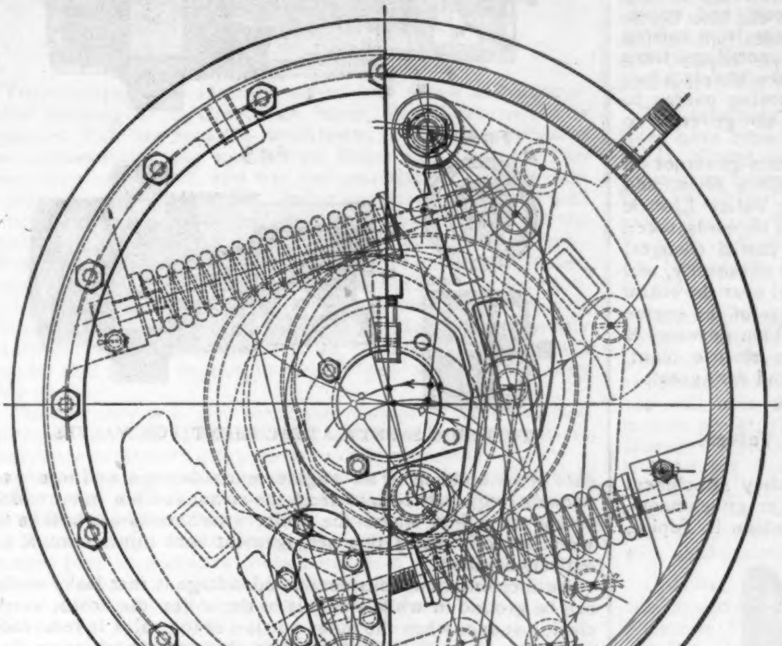


Fig. 2.

in operation. The holes having been drilled, as has already been shown, the spindle with the enlarged end is placed in the holes to be threaded, the enlargement entering the hole in the outer shell. The taper-tap is then placed on the spindle, and the hole in the fire-box sheet is threaded from the inside. The enlarged end of the spindle fitting the hole in the outer sheet and the tap the hole in the inner sheet, the latter will be guided in a straight line and forced to cut a thread corresponding in direction and pitch with that of the outer sheet. When the hole in the fire-box is threaded, the tap and spindle are removed, and the spindle having the threaded end and round nut is substituted, the nut being placed in the hole of the outer sheet as shown. This affords a firm bearing for the spindle and will necessarily guide the plug tap in a straight line, at the same time allowing it to enter and cut its thread in the hole of the outer sheet until the end touches the round nut, when, by pulling back on the spindle and turning it, the nut will be unscrewed and dropped down by the side of the fire-box. The tap, however, will then have a firm bearing, and the threading of the outer hole can be completed. The threads will then necessarily be in a straight line and will correspond, the tap being guided by the thread already made in the fire-box sheet and by the nut in the outer sheet.

The saving in time and expense in making repairs on a locomotive by the use of these devices can readily be understood by those who have had similar work to attend to. These devices have been fully tested in practical use.

The Westinghouse Governor.

THE chief points of excellence in a steam-engine governor are its quickness of action and ability to handle the engine under great changes of load. In experimenting for a governor to meet these requirements the Westinghouse Machine Company has finally adopted one which, it is claimed, presents some points of advantage over any other now in use.

This governor is shown in the accompanying cuts, fig. 1 being a perspective view, showing the governor in use, running in a case filled with oil; fig. 2 a half plan and half section, and fig. 3 is a cross-section through the center, showing the position of the eccentric. These views show its simplicity of construction and the absence of the usual adjustments in the form of balanced eccentrics, unloading device, dash-pots, etc.

The details of the construction are shown by the drawings. A heavy unbalanced eccentric and strap place the center of

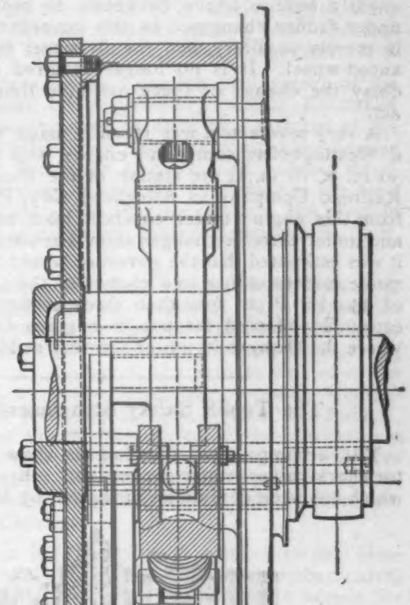


Fig. 3.

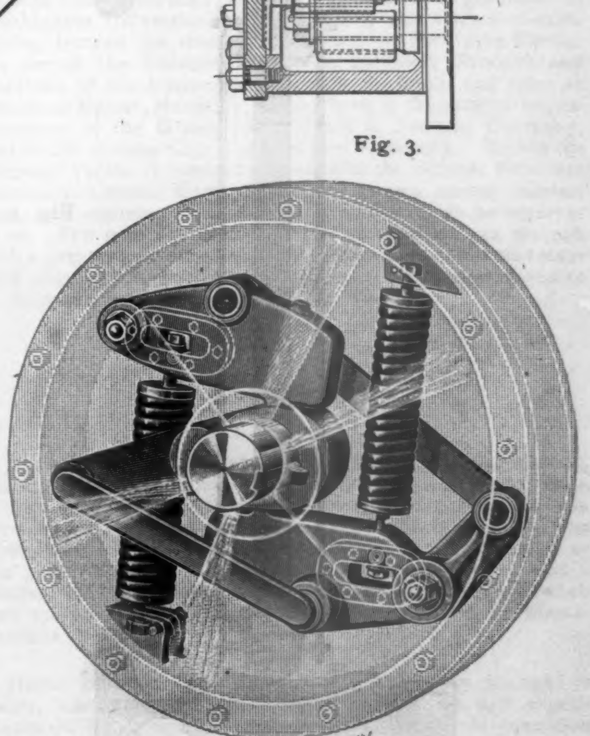


Fig. 1.

THE WESTINGHOUSE GOVERNOR.

gravity of the combination very near the center of the shaft without sacrificing strength. Short heavy springs with a low initial tension are used, and the governor is so compact that it is placed in a heavy case completely filled with oil, so as to

insure free lubrication. While it is heavy and perfectly free to move even through the whole range, if necessary, its strength is a variable quantity and the leverage increases so as to meet and resist the greater strains of longer cut-offs. The chief excellence of the governor, it is claimed by the makers, is its ability to utilize its inertia for the rapid adjustment required to meet instantaneous changes of load. The tendency of the engine to change its speed as demanded by the regulation on account of change of load throws the governor to the new position to suit the new load, the inertia being the force which changes the adjustment of the governor. In this point it differs from other devices of this class, which are usually actuated by changes of centrifugal force alone, and consequently require heavy fly-wheels to keep them from raising under sudden changes. In this governor the centrifugal force is merely auxiliary, and the fly-wheel becomes simply a balanced wheel. It is no longer required in storing energy to delay the change of speed and give time for the governor to act.

A very severe test was recently made with this governor on a Westinghouse compound engine with cylinders 18 in. and 30 in. × 16 in. at the station of the Pleasant Valley Electric Railroad Company in Allegheny City, Pa. The cards taken from this engine under constant load, under partial changes, and under extreme changes show a remarkable uniformity, and it was estimated that the governor would travel over the entire range corresponding to a change of the capacity of the engine of 250 H. P. in less than three seconds. This governor is especially adapted for use in engines for an electric plant, where the changes in power are very sudden and very great.

The Topliff Safety Attachment for Valves.

THE accompanying illustrations show a safety attachment for check-valves, water-gauges and other boiler attachments, which has been devised and invented by Mr. Judson B. Topliff,

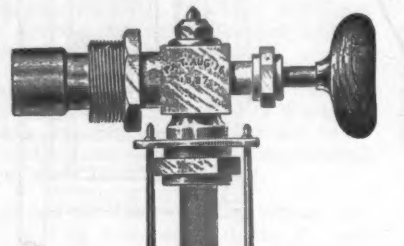
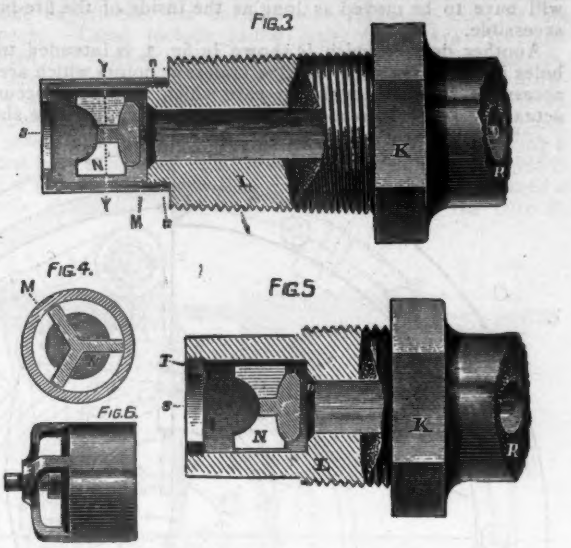


Fig. 1.

of Toledo, O. Fig. 1 shows a glass water-gauge provided with this attachment, while figs. 3, 4, 5 and 6 show different forms of the valve upon a larger scale. The idea will be readily seen from the illustrations. It is to provide a supplementary valve which, in case of the breaking of the gauge, check-valve, or other attachment in any way will be at once automatically closed by the greater pressure of steam in the boiler, and will thus prevent any escape of steam. It is well known that in



TOPLIFF'S SAFETY ATTACHMENT FOR VALVES.

case of an accident to an engine much damage and injury to persons frequently results from the steam and hot water which escape at points where the boiler attachments are broken or wrenched off, but by this arrangement such injuries would be entirely avoided.

An incidental but considerable advantage is that leaky cocks can be ground in while steam is in the boiler, the inside valve closing at once when the outer portion of the valve is removed. It is also claimed by the inventor that in a check-valve this attachment will increase the capacity of the injector considerably and the valve will not become useless from corrosion, mud or any sediment in it, since the valve will remain closed except when the injector is working and no sediment from the boiler can be forced into the check. This claim has been substantiated by actual experience on a locomotive.

The advantages of this arrangement will readily be seen by practical men, and the device seems well adapted for the purpose for which it is intended.

Brake Shoes.

IT might be of interest to readers to know that wood brake shoes were used by railroads in their earlier days.

Wood brake shoes were in general use on the Baltimore & Ohio cars, with the exception of iron coal cars, from its opening until about 1853. The shoes were principally of ash, but oak was used to some extent.

After the line crossed the Alleghanies it was soon discovered that wood brake shoes would not answer, as they burned out while descending the heavy grades, and a wrought-iron shoe riveted to a cast-iron block superseded the wood shoe. The wrought-iron shoe has since been superseded by the cast-iron shoe for passenger and freight equipment.

Baltimore Notes.

A CERTIFICATE of incorporation of the Maryland Bolt & Nut Company of Anne Arundel County has been filed in the office of the clerk of the Circuit Court, at Annapolis. Following are the incorporators: David L. Bartlett, J. Olvey Norris, W. F. Frick, C. A. Hotchkiss, Thurston Rawlins, Howard Carlton, and George A. Von Lingen. The location is Curtis Bay. The capital stock is $100,000.

THE Baltimore & Ohio Railroad has just closed a contract with the Pullman Company for 36 first-class coaches and 6 combined passenger and baggage cars.

THE Wells & French Company, Chicago, is building 75 gondola cars of 60,000 lbs. capacity for the Pittsburg & Chicago Gas Coal Company.

THE South Baltimore Car Works, Curtis Bay, have just closed a contract with the Youghiogheny River Coal Company for the construction of 200 hopper gondolas of 60,000 lbs. capacity.

THE compound engine built by the Baldwin Locomotive Works for the Baltimore & Ohio is now in Mt. Clare shops, being changed to a simple engine.

THE Baldwin Locomotive Works are building three new passenger engines for the Baltimore & Ohio Railroad, which are to have 78-in. wheels.

The Baker Heater Company.

THIS Company has recently moved into a new and commodious building at 799 Greenwich Street, New York, which is equipped with the requisite machinery, tools, and appliances for manufacturing the well-known Baker Car Heater. This was invented in 1868, and was not materially improved until seven years ago, when Mr. Baker commenced making and putting into use various improvements which resulted in the production of a heater in which the fire is enclosed and completely enveloped within a soft flexible wrought-steel cylinder, which would be crushed, but cannot be broken in a collision. This cylinder is made by welding the longitudinal joint of the plates and also the two heads, thus making it practically jointless. This improvement is so obvious that it seems a wonder that all car heaters have not been made in this way long ago.

The new shop will give the Baker Company improved and increased facilities of manufacture, and new improvements in details are constantly being made in their apparatus.

After a long litigation in the Patent Office, occupying over three years, a decision has just been rendered in favor of W. C. Baker as the first inventor of the combination with a car "of a system of circulating pipes within said car, and two heaters both in operative contact with said circulating system, or with branches thereof, and adapted to be operated simultaneously or separately for imparting heat thereto."

PERSONALS.

A. F. HARLEY has been appointed City Engineer of Jacksonville, Fla.

L. B. JACKSON has resigned his position as Chief Engineer of the Chesapeake & Ohio Railroad.

W. BARCLAY PARSONS has been appointed Assistant Engineer of the New York Rapid Transit Commission.

GEORGE H. BAKER has been appointed Fuel Expert of the Southern Pacific Company, with headquarters in Sacramento.

ALFRED P. BOLLER, of New York, the well-known bridge engineer, has been elected a member of the British Institution of Civil Engineers.

W. H. HUDSON is appointed Master Mechanic of the Atlanta and the Brunswick Divisions of the East Tennessee, Virginia & Georgia Railroad, in place of E. M. ROBERTS, resigned.

N. W. EAYRS has been appointed General Manager of the Wheeling Bridge & Terminal Company at Wheeling, W. Va. He was recently engineer of the St. Louis Terminal Railroad.

WILLIAM H. V. ROSING has resigned his office as Assistant Master Mechanic of the Illinois Central Railroad, to accept a position with the new Grant Locomotive Works in Chicago.

EDWARD ELLIS succeeds the late Charles G. Ellis as President of the Schenectady Locomotive Works. WILLIAM D. ELLIS succeeds Mr. Edward Ellis as Treasurer of the Company.

A. C. BASSETT has resigned his position as Superintendent of the Coast Division of the Southern Pacific, and will take charge of the Loma Pietra Lumber Company in Southern California.

C. C. ELWELL has been appointed Engineer of Maintenance of Way of the Pittsburgh Division, Baltimore & Ohio Railroad, succeeding W. A. PRATT, who has been transferred to the Philadelphia Division.

W. A. STONE is appointed Master Mechanic of the Alabama Division of the East Tennessee, Virginia & Georgia Railroad, in place of C. L. PETRIKIN, who has resigned to engage in manufacturing business.

HARVEY MIDDLETON, late Superintendent of Motive Power of the Union Pacific, has been appointed Superintendent of Construction of Pullman's Palace Car Company, and will have his office at Pullman, Ill.

JAMES HARRINGTON has been appointed Chief Engineer and General Superintendent of the Cleveland, Akron & Columbus Railroad, and JOHN J. HENRY Superintendent and Master Mechanic. As Superintendent Mr. Henry succeeds R. G. SHARPE, who has resigned.

JOHN W. HOBART has resigned his position as General Manager of the Central Vermont Railroad. He has been connected with the road for 43 years, beginning as freight clerk, and holding successively the positions of Station Agent, General Freight Agent, General Superintendent, and General Manager. Mr. Hobart retires from business altogether.

THE following changes in the Engineer Department of the Navy have been directed by the Secretary: CHIEF ENGINEER H. B. NONES has been ordered to duty as a member of the Examining Board in Philadelphia; he is relieved at the League Island Yard by CHIEF ENGINEER A. S. GREENE; CHIEF ENGINEER WILLIAM W. DUNGAN is relieved from duty at the New York Navy Yard and placed on waiting orders. His place in the New York Yard is taken by CHIEF ENGINEER S. L. P. AYRES.

THE following changes on the Chicago, Rock Island & Pacific Railroad result from the death of Mr. Verbryck: GEORGE F. WILSON, heretofore General Master Mechanic, is appointed Superintendent of Motive Power and Equipment, and will have charge of the car department as well as of the motive power; H. MONKHOUSE, heretofore Assistant General Master Mechanic and Assistant General Master Car-Builder, is appointed Assistant Superintendent of Motive Power and Equipment, with headquarters at Horton, Kan., and will have charge of the Company's Southwestern lines; JOHN BLACK, JR., is appointed Master Mechanic of the Illinois Division, with headquarters in Chicago.

COLONEL CLARENCE H. HOWARD, for some time past General Superintendent of the railroad department of the Scarritt Furniture Company, St. Louis, resigned June 1 to accept the position of Vice-President and General Manager of the St. Charles Car Company. Colonel Howard is a graduate of Washington University, St. Louis; he is also a practical man, having learned the trade of machinist on the Union Pacific. He served the Missouri Pacific as Assistant Foreman and Foreman of the locomotive shops in St. Louis, and later as Assistant Master Mechanic, having been in the interval Superintendent of the Missouri Car Wheel & Foundry Company, and of the Kansas City Car & Wheel Company. He left the Missouri Pacific to connect himself with the Scarritt Furniture Company. Colonel Howard is widely known among railroad men, and wherever he is known is esteemed, as he deserves to be. Few men are more popular, and few can get through with a greater amount of work in a given time. His successor with the Scarritt Furniture Company is his brother, GEORGE E. HOWARD, recently with the Union Pacific.

OBITUARY.

JAMES C. CONVERSE, who died in Greenfield, Mass., May 25, has been for some years past President of the National Tube Works Company, of Boston and McKeesport, Pa. He was for a number of years engaged in business in Boston, and was one of the founders of the successful concern now known as the National Tube Works Company. Mr. Converse was a leading advocate of the construction of the Hoosac Tunnel, and served one term as Railroad Commissioner of Massachusetts.

DAVID BROOKS, who died in Philadelphia, May 30, aged 71 years, was engaged with Professor Moss in his first experiments on the telegraph, and assisted in putting in operation the first telegraph line built in America. He was engaged in building new lines for a number of years, and in 1851 built the line between Vera Cruz and the City of Mexico, the first one in that country. For a number of years he was in the service of the Pennsylvania Railroad Company and afterward of the Western Union Telegraph Company, but since 1867 had devoted his time to inventions and improvements in telegraph and telephone service, many of which are in successful use. In 1873 he served as Commissioner to the Vienna Exposition.

Charles H. Dunham, who died in Chicago, June 3, was well known among railroad supply men, and had been engaged in a number of enterprises, the most successful of which was the introduction of the Dunham car door, with which, in connection with some other patent devices, he established a flourishing business, which was afterward transferred to the Q. & C. Company. Mr. Dunham then undertook the establishment of a great railroad supply agency on so extravagant a scale that it could hardly be expected to succeed. He was very popular among his wide circle of friends and acquaintances, being a very genial and generous man, but a lack of self-restraint prevented his final success.

B. K. Verbryck, who died suddenly in Chicago, June 2, aged 67 years, began work on the Erie, where he reached the position of Foreman in the old Piermont shops; he was afterwards for 26 years in the service of the Chicago, Rock Island & Pacific Railroad, and for a number of years past was Master Car-Builder of that road, having entire charge of its cars. Mr. Verbryck had been so long with the Rock Island Road that he was in a measure identified with that road, but was known throughout the country as an officer of ability and a man thoroughly versed in his business. He was a member of the Master Car Builders' Association from its early days, taking a prominent part in its proceedings. He served a year as Vice-President and one year as President of the Association.

Colonel John Albert Monroe, who died in Providence, R. I., June 11, had resided for many years in that city. He was 54 years old, and graduated from Brown University in 1860. He served during the war as an officer of artillery, attaining the rank of Colonel and Chief of Artillery of the Second Army Corps. After the war he took up the profession of civil engineering, and was engaged on many important works. In 1878 he was appointed Assistant Engineer to the Mississippi River Commission, and made complete surveys of the river from Cairo to Memphis. Later he had charge of the building of part of the West Shore Railroad, and built water-works for Bismarck, N. D., and several other cities. He was Resident Engineer in charge of the construction of the Thames River Bridge, which was his last work. He was one of the oldest members of the American Society of Civil Engineers, and took a prominent part in the proceedings of that Society.

Chauncey Vibbard, in his time one of the best-known railroad men in America, died June 5, at Macon, Ga., where he had gone for his health. He was 79 years old. He was born in Saratoga, N. Y., and at an early age became clerk in a store in Albany, and for several years was employed in business in that and other cities. In 1836 he was made Chief Clerk of the old Utica & Schenectady Railroad, then just completed, and held that position until 1848, when he was made General Superintendent of the road, of which Erastus Corning was then President. In connection with Mr. Corning he arranged the consolidation of the companies owning the different links of railroad between Albany and Buffalo, which resulted in the formation of the New York Central Company in 1853. Mr. Vibbard was made General Superintendent of the consolidated line and held that position until 1865, when he resigned and removed to New York, where he has since resided. For a number of years he was actively engaged in business there, but retired some years ago, although he retained an interest in various enterprises, including the Day Line of Steamers between Albany and New York, and a number of Southern railroads. From 1861 to 1863 Mr. Vibbard represented the Albany district in Congress, and for a short time in 1862 he was Director of Military Railroads, resigning that position, however, as soon as the War Department had completed its railroad organization. It is Mr. Vibbard's great distinction that he was one of the first to see and recognize the necessity of consolidation, in order to secure the proper and economical management of the great through lines to the seaboard, and that he also foresaw before almost any other railroad man in the country the great decrease in railroad rates which was coming, and realized that it could only be met by corresponding economy in transportation. He was at one time a very wealthy man, but leaves only a moderate fortune.

PROCEEDINGS OF SOCIETIES.

National Convention of Railroad Commissioners.—The Committee on Safety Appliances appointed at the last convention has decided that information on the following subjects should be obtained:

The total number of freight cars owned, leased, or otherwise controlled by each company, and how many are equipped with automatic couplers.

The kinds of couplers used, and the number of cars with each kind.

The kind of couplers each company now causes its freight cars to be equipped with.

The number of freight cars each company has equipped with train brakes, and the names of the brakes used.

The number of locomotives each road owns, leases or controls, and the number equipped with driving-wheel brakes.

The opinion of railroad officials as to the way in which the equipment of freight cars with uniform automatic couplers can best be hastened.

The Committee has also determined that a circular setting forth the resolutions of the Convention under which the Committee is acting, and requsting such information, be sent to all railroad companies engaged in carrying Interstate commerce.

It has also determined that another circular embodying the resolutions above referred to be sent to organizations of railroad officials or employés with the request that any communications which they may desire to submit in relation to the subjects covered by the resolutions be sent to the Committee in care of Edward A. Moseley, Secretary, at the office of the Interstate Commerce Commission, Washington, D. C., and should a hearing be desired by any organization to notify the Committee thereof on or before August 1.

The next meeting of the Committee will be held in New York, November 10. Mr. George G. Crocker, of the Massachusetts Commission, is Chairman, and E. A. Moseley Secretary.

Association of Railroad Accounting Officers.—The third annual convention was held in St. Louis, May 27 and 28, about 150 members being present.

Reports were received and acted upon from freight, passenger and other committees. Among other things, a modified plan of settlement of joint freight accounts, based on the plan adopted by the association two years ago, and known as the Niagara Falls plan, was adopted.

Addresses were read to the convention as follows:

W. K. Gillett, Proper Checks for Auditing Daily and Monthly Reports of Local Passenger Traffic.

E. R. Murphy, Materials Account—Proper Relation of Accounting Departments Thereto.

Officers were elected for the ensuing year as follows: Cushman Quarrier, Louisville & Nashville, President; D. A. Waterman, Michigan Central, First Vice-President; Chauncey Kelsey, Chicago & Alton, Second Vice-President; C. G. Phillips, Chicago & Northwestern, Secretary and Treasurer. To take the place of retiring members of the Executive Committee the following were elected: G. W. Booth, Baltimore & Ohio; G. L. Lansing, Southern Pacific Company; M. Riebenack, Pennsylvania Railroad; Carlton Hillyer, Georgia Railroad.

Master Car-Builders' Association.—The Annual Convention met at the Stockton Hotel, Cape May, N. J., 97 members answering to the opening roll-call. After a short address by the Mayor of the City, the President, Mr. John Kirby, delivered his annual address, in which he referred to several points requiring the attention of the Convention, among which he included the diversity of design of the M. C. B. type of couplers coming into use, the excessive use of defect cards, the progress made in equipping freight cars with automatic brakes and couplers. He also referred appropriately to the recent death of ex-President Verbryck.

The Secretary reported that the Association now has 278 members, of whom 158 are active, 115 representative, and 5 associate members. Mr. H. G. Prout and Mr. D. L. Barnes were elected associate members. The President then appointed committees to nominate officers, to report subjects, to audit accounts, and on correspondence and resolutions.

The Joint Committee on Time and Place of Meeting reported that they had agreed to recommend a change in the constitution of both associations, arranging that the Master Car Builders' Association meet on the second Wednesday in June, and the Master Mechanics' Association on the Monday following; the place of meeting to be fixed by the officers of the two associations acting jointly. The report was approved and the necessary resolution adopted.

Reports were then presented by the committees on Lettering Freight Cars, on Steam Heating and Ventilation, and on Pressed Steel and Malleable Iron in Car Construction. The last-named report presented some statements as to the use of steel and some tests of strength of malleable iron, and its report was discussed at considerable length. It was resolved

that a Committee be appointed to report to the next Convention a standard for stake pockets, and one for pressed steel center-plates for car trucks.

The other reports were accepted and the Committee on Steam Heating was directed to report a standard connection between the hose and pipe and a standard location for the end of the steam-pipe.

On the second day a Committee was appointed in response to a communication received from the officers of the Columbian Exposition to consider the question of co-operation of the Association. The rest of the meeting was devoted, according to custom, to the discussion and amendment of the standard rules for interchange, the principal points brought up this year being in relation to defective wheels and wheel guarantees; to the maintenance of standards for M. C. B. standard coupler and to air-brake standards and the inspection and care of air-brakes on freight cars. The last named was of the most importance, in view of the rapid increase in the number of cars furnished with air-brakes.

At the third's day's session resolutions were adopted in favor of co-operation of the Association in the great Exposition at Chicago.

The Committee on Wheel Guarantee presented a report stating that no conference had been held with the Wheel Makers' Association. The Committee was continued to report at the next meeting of the Association. The Committee on Metal for Brake-shoes was also continued, Mr. J. N. Barr being added to it.

The report of the Executive Committee on the Standard Coupler was discussed at some length, and it was resolved that the Executive Committee be authorized to make the necessary arrangements for supplying templates for the use of railroads and manufactures of couplers. A resolution was also adopted for the appointment committee to consider whether any changes from the present limits would be advisable.

It was resolved to submit to letter-ballot the form of journal-box and bearing for 60,000-lbs. cars submitted by the Committee.

A number of places were suggested for the next meeting, including Cleveland, Alexandria Bay, Saratoga, Lakewood, N. Y., and Boston.

The usual resolutions of thanks, etc., were adopted, and committees were appointed to prepare suitable memorials of Mr. B. K. Verbryck and B. C. Richardson.

The officers chosen for the ensuing year are: President, John Kirby; First Vice-President, E. W. Grieves; Second Vice-President, J. S. Lentz; Third Vice-President, T. A. Bissell; Treasurer, G. W. Demarest; Secretary, J. W. Cloud; Executive Committee, R. C. Blackall, E. Chamberlain, F. D. Casanave.

Master Mechanics' Association.—The Annual Convention met at Cape May, N. J., June 16. An opening address was delivered by Congressman Reyburn, of Pennsylvania. The opening roll call showed 107 members present.

The President, Mr. John Mackenzie, delivered his annual address, in which he urged the necessity of further efforts to decrease the cost of transportation. The object of the motive power officer should be to make locomotives more economical in the use of fuel, and at the same time have them pull heavier trains. He also called attention to the need of action on safety appliances for locomotive and cars.

The Secretary reported that there were now on the roll 14 honorary, 430 active, and 14 associate members, the increase in members last year being the largest ever made in any one year. The usual committees were appointed.

The Committee to confer with the Master Car Builders' Association reported an amendment, the same as that submitted to the other Association, which was adopted. It provides that the Master Car Builders' meet the second Wednesday in June and the Master Mechanics on the Monday following, the place of meeting to be determined by the officers of the two Associations, acting jointly.

A resolution was adopted providing for the incorporation of the Association under the laws of New York.

Mr. Charles B. Blackwell read a paper on Flanging Steel at other than red heat, which called out considerable discussion. He presented some remarkable samples of flanged steel.

The Committee on Exhaust Pipes, Nozzles and Steam Passages presented a report which was accompanied by a number of drawings and indicator diagrams taken from locomotives on the Richmond & Danville and the Cincinnati Southern roads. The Committee recommended that the exhaust-pipes should be so arranged as to make the exhaust as free as possible and avoid back pressure; that the discharge should be nearly central with the stack, and that the exhaust-pipe should terminate at such distance from the base of the stack as to insure its being completely filled at each discharge. A taper stack was recommended. This report also called out a long discussion in which a great variety of practice was indicated, as usual.

The Committee on the Advantages and Disadvantages of Placing the Fire-Box above the Frames asked to be discharged, which was done.

At the second day's session, the Committee on Iron and Steel Axles presented a report, submitting the facts collected, but declining to make any positive recommendations. This report was also discussed, but without reaching any conclusions. The report of the Committee on Testing Laboratories for Railroads was presented. It recommended the use of such laboratories in charge of proper officers as Engineer of Tests and Chemist, and gave estimates as to the cost of the necessary machinery. Instances were given of the saving secured in many cases by careful tests of materials purchased. Quite a lively discussion was held over this report.

The Committee on Disposal of the Boston Fund recommended the establishment of scholarships at the Stevens Institute, Hoboken, on the terms offered by that Institution. The report was adopted and the officers directed to carry out its recommendations.

When the hour for general discussion arrived Mr. Vauclain addressed the Association on Compound Locomotives, and was followed by other speakers, much interest being taken in this subject.

The Committee on Purification of Feed-Water then presented its report, which was briefly discussed, Mr. Gibbs giving some facts as to the great gain secured by purifying bad water.

The Committee on the M. C. B. Standard Coupler presented a verbal report, which was received, and the Committee continued. A resolution was adopted in favor of the use of the vertical plane coupler.

The Committees on Examination of Engineers and Firemen, and on Operating Locomotives with Different Crews, presented reports which were received and laid over for further discussion.

At the third day's session there were brief discussions on both these reports, and a report was presented by the Committee on Locomotives for Heavy Fast Service. This presented the results of information collected, and stated that the preference appeared to be for the use of a ten-wheel rather than a mogul engine for such service, but declined to make any positive recommendation until further experience had been had with this type of engines, which had only been for a short time introduced on passenger trains.

The following subjects for discussion for next year were reported and approved:

1. Locomotive Indicators.
2. Compound Locomotives.
3. Special Tests and Investigations.
4. Uniform Standard of Comparison for Locomotive Performance.
5. Couplers.
6. Exhaust-Pipes and Nozzles.
7. Electric Appliances.
8. Air-Brake Rules.

Mr. John Mackenzie was re-elected President and Angus Sinclair Secretary, with the other officers of last year.

New England Water-Works Association.—The 10th Annual Convention began at Hartford, Conn., June 10, with a large attendance. President A. P. Noyes delivered the annual address, stating that the Association now has 360 members, and is in a prosperous condition, having a balance of $2,000 in the treasury. After the routine business had been transacted, the Committee on Classification of Rates presented its report, and Mr. Freeman C. Coffin read a paper on Standard Flanges for Water-pipes.

At the evening session papers on experience with the Water Hammer, by E. E. Farnham, and on Lead Pipe Connections for Iron Service Pipe, by H. G. Holden, were read and both were discussed. Discussions were also held on several topics suggested by members. After the meeting reception was given to the members at the Allyn House.

On the second day, Thursday, a portion of the morning session was devoted to the usual routine business. Papers were presented by J. C. Hancock on the Risk of a Single Supply Main; by S. E. Babcock, on Water Pipe Joints; by George F. Chase, on Direct Pumping Systems.

Afternoon and evening sessions were also held on this day, the afternoon session being devoted to the reading of papers, including one on the New Haven Water Company's Dam, by L. A. Taylor; one on Dangers through Tunnel or Low Grade Aqueducts, by D. FitzGerald, and one on Studies on Algæ and Infusoria in Water, by F. F. Forbes.

The evening session was devoted to discussion of topics suggested. Among those presented at the Convention were Minimum Size of Mains; Water Meters; House Inspection; Ordinary and Fire Supply for Factories; Service Pipes, and Reasons why a Hydrant does not deliver full supply.

The third day was principally given up to a visit to the reservoirs of the Hartford Water-Works under the escort of the Water Commissioners of the City. In the afternoon the convention adjourned, after an unusually successful meeting.

American Boiler Manufacturers' Association. The annual meeting of this Association was held in St. Louis, May 12, 13, and 14, and some important discussions were had. Reports were submitted by the Committees on Material and Tests, on Boiler Tubes, on Man-holes and on State Inspection Laws. The rules governing inspection by the United States were also discussed and a form of bill drawn up and presented.

The officers elected for the ensuing year are: President, James Lappan, Pittsburgh, Pa.; First Vice-President, Philip Rohan, St. Louis; Second Vice-President, James Kenney, St. Paul; Third Vice-President, Charles Kroeshell, Chicago; Secretary, E. D. Meier, St. Louis; Treasurer, Richard Hammond, Buffalo, N. Y.

American Society of Civil Engineers.—The Annual Convention began, according to programme, at Chattanooga, Tenn., May 21, and continued until May 26, with a very large attendance of members. The feature of the meeting was the annual address of President Chanute, which referred at considerable length to the important engineering works of the year, including tunnels, ship canals, bridges and other works. Mr. Chanute also referred at considerable length to the future of the Society and spoke of the best method of increasing interest in the same.

Among the more important papers read was one by Mr. John E. Greiner on the American Railroad Viaduct; one by W. B. Parsons on Mountain Railroad Construction; one by R. W. Griffin on Car-Wheels. A number of other papers of interest were also presented and discussed.

There was a lively discussion on the appointment of a nominating committee and upon the method of nominating officers of the Society. A number of candidates were presented, and will be voted upon by letter ballot.

During the continuance of the meeting the members visited numerous points of interest in Chattanooga and vicinity. The annual banquet of the Society was held on the evening of May 24, about 100 members being present with a number of guests, including ladies.

American Institute of Mining Engineers.—The summer meeting was held in Cleveland, O., beginning Tuesday, June 2. Business sessions were held on Tuesday, Wednesday, Thursday, and Friday. Wednesday and Thursday were largely given up to visits to local works, and Friday afternoon was devoted to an inspection of the ore docks, shipyards and water works of Cleveland. The annual dinner was held in the evening of Thursday, and was largely attended.

American Society of Mechanical Engineers.—The last social gathering for the season was held at the club house in New York, May 28. A portrait of Mr. Henry R. Worthington was presented to the Society. Dr. R. W. Raymond made an address on Egypt, giving some notes gathered by him while on a visit to that country last winter.

These social gatherings have been a feature much enjoyed by resident and visiting members, and will be continued next winter.

Technical Society of the Pacific Coast.—At the regular May meeting in San Francisco, Mr. R. Hinchcliffe read a paper on the Hall Hydro-Steam Elevator.

Mr. Gutzkow exhibited an induction pump for raising liquids. Mr. W. N. Anderson exhibited a device for working elevator doors automatically.

Western Railway Club.—At the May meeting in Chicago, there was a discussion on the subject of Air-Brakes of Interchange Cars, in which many members joined and a set of rules was adopted for submission to the Master Car Builders' Association.

Professor W. F. Johnson read a paper on Steam Heating, which was discussed.

Mr. Barr read a note about Bending Steel at different temperatures.

The meeting was closed by a short discussion on Joint Inspection of Cars.

Engineers' Society of St. Louis.—At the regular meeting in St. Louis, May 20, Messrs. B. E. Chollar and E. A. Herman were chosen members.

Mr. Carl Gayler then read a paper on Viaducts Across the Railroad Track in St. Louis, describing some of the difficulties encountered with bridges over the tracks in that city, and some of the accidents which had occurred. In conclusion he offered some suggestions as a result of the experience obtained with existing bridges. This paper was generally discussed by members present.

At the regular meeting, June 3, R. E. McMath was chosen Librarian. A committee was appointed to revise the Constitution.

Dr. Wellington Adams read a paper on Mechanical Propulsion of Road Carriages, in which he advocated the use of a high-speed rotary steam-engine with steam produced by burning oil. This paper was pretty sharply discussed by members present.

Wisconsin Polytechnic Society.—This Society was organized in November last at Milwaukee, and was incorporated in March of this year. It has a considerable membership and holds regular meetings on the second Monday in each month.

NOTES AND NEWS.

Bids for New Lightships.—The Lighthouse Board has been receiving bids for four new lightships, to be known as Nos. 51, 52, 53 and 54, and to be stationed respectively at Cornfield Point, Long Island Sound; Fenwick Island Shoal, off the New Jersey coast; Frying Pan Shoal, off the North Carolina coast, and Martin's Industry, off the Georgia coast.

These lightships will be far superior to any heretofore built and will embody many novel ideas, the most important of which is giving them propellers and steam-engines, so that they will not be entirely at the mercy of the sea. They can steam out to their stations without assistance, and in many storms, when they would be blown from their anchorage, they can ease the strain on their anchor chains by steaming against the storm. Then, if cast adrift, they will not be helpless, but can make the nearest port. Their steam outfit will include a steam windlass and a small engine for working the steam fog signal.

The general dimensions of the ships will be: Length over all, 118 ft. 10 in.; beam, 26 ft. 6 in.; depth of hold, 14 ft. 6 in. They will be built of iron and steel, and the hulls will be subdivided by four main bulkheads, extending up to the main deck. Bilge keels 55 ft. in length will be worked on each side of the vessels, and will help to steady them in rough weather. Another novelty that will contribute to the steadiness of the vessels is the arrangement of the hawse-pipes, which will pass directly through the stern-posts of the vessels, instead of at one side, so that they will pull more evenly on their cables. The vessels will be rigged with two masts and try-sail masts.

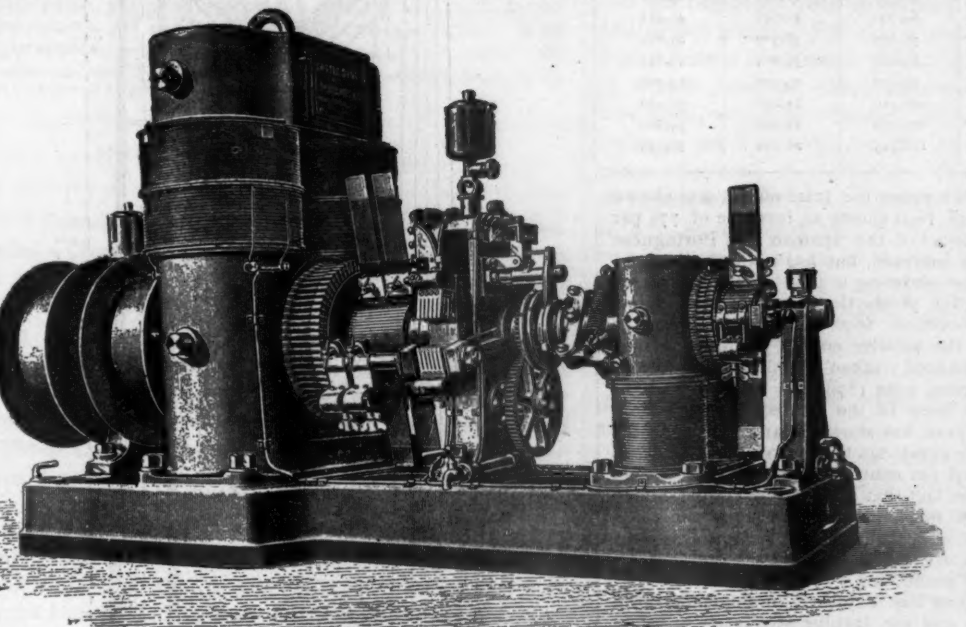
The Cornfield Point vessel will be provided with flash electric lights, four of them being carried in lense lanterns at each masthead. Each of these separate lights will be about equal to the ordinary sixth-order light. The electric plants will be in duplicate throughout. The Lighthouse Board is now experimenting at Staten Island with revolving screens for light-vessel lights, and it is probable that, when these vessels are completed, Nos. 52, 53 and 54 will also have lights with distinctive characteristics. The vessels are to be completed within ten months from the date of contract.

Roads and Vehicles.—In a paper recently read before the Engineering Association of the South, Mr. J. M. Heiskell presented the argument that economy of street and highway traffic could best be secured by paying attention to improving the vehicle rather than the road surface, and to accomplish this recommended strongly the introduction by proper legislation of the following features in the construction of vehicles: 1. Width of tire to be dependent on weight of load. 2. Length of axle to be dependent on weight of load in order to insure non-tracking of vehicles. 3. A difference of length between front and rear axle to insure non-tracking between front and rear wheels. 4. The introduction of springs for heavy draft wagons. The paper presented estimates based on quotations from paving companies, giving their prices for guaranteeing the maintenance of their pavements for terms of years under existing circumstances and also under conditions to be secured by legislation requiring the above improvements in vehicles.

Dynamos for Train Lighting.—In England and in France, where more progress has been made in the use of electricity for lighting trains than in this country, the chief difficulty found has been the variation of speed in driving the dynamos. Separate engines have been used and have been found not altogether satisfactory. The accompanying illustration and description, which are taken from our excellent contemporary, *Industries*, shows a solution devised by J. H. Holmes, of Newcastle-on-Tyne, England. This dynamo has been used with much success on the Midland Railway in England, the Northern Railroad in France, and on some lines in Germany and in Russia, and has, it is claimed, passed beyond the stage of experiment. The inventor explains his device as follows:

Practically, the e.m.f. of an ordinary separately excited dynamo varies directly as the speed, so if the speed be increased, say, from 500 revolutions per minute to 1,000 revolutions per minute, the electro-motive force will be doubled. The electro-motive force varies directly as the strength of the magnetic field, so that, if the strength of field of a separately excited dynamo be reduced in the same proportion as the speed at which its armature revolves be increased, the electro-motive force of the armature will remain practically constant.

To produce this result two dynamos are arranged having their armatures upon the same shaft, so as to revolve together, but



influenced by separate magnetic fields. One is the main generating machine, the other is for regulating the strength of its magnetic field. The magnets of the machines are separately excited from an external source, such as a set of accumulators, and the magnets of the generating armature are provided with two distinct exciting circuits. One circuit is an ordinary high-resistance shunt circuit, and the other is of less resistance, and is coupled up to the source of current so as to have the small regulating armature in series with it. The regulating armature is so coupled up that its electromotive force opposes the electromotive force of the regulating armature and external source of supply. The high-resistance shunt circuit is so proportioned that, at the highest speed at which it is intended to run the generating armature, it, without the aid of the regulating circuit, will give a magnetic field of an intensity proper for the required e.m.f. in the generating armature. When thus driven the second exciting circuit ought to have no current passing through it, and this is secured by making the e.m.f. of the regulating armature at its highest speed equal and opposite to the external source of e.m.f. produced in the second coil of the generating machine. If, however, the speed falls, the e.m.f. of the regulating armature is reduced in the same proportion, and is no longer equal to the external e.m.f., and a current will flow through the second exciting circuit of the magnets of the generating dynamo, thus increasing the intensity of the magnetic field to make up for reduction of speed, maintaining a practically uniform e.m.f.

The armature is driven by belting from the axle of the guard's van, and a set of accumulators excite the field magnets. A centrifugal governor automatically switches the storage batteries in or out. The brushes which collect the current from the two armatures are made of wire gauze, and are placed radially, the "lead" being automatically altered to suit the direction of rotation. The connections to the armatures are changed at the same time.

It may be noted here that, in a paper recently read before the Royal Society in London, it was stated that the cost of fitting a car for electric lighting on the Midland Railway was about $240, while the special van or car carrying the dynamo cost from $1,200 to $1,400. The actual running cost for electricity as used on the Midland Railroad was about 0.5 cent per lamp per hour, being a little over one-half the cost with compressed gas.

An Ingenious Arrangement of Power.—At the new works of the Newport News Shipbuilding & Dry Dock Company at Newport News, Va., the various shops are necessarily separated from each other, and the primary engineering conditions are such as to demand the subdivision of power almost as a necessity. The key to the successful subdivision of power was found in the use of a type of engine, whose specific economy in moderate sizes should be as good, or better, than that of a single large central engine; and further, in the use of some practical device for preventing the dangerous accumulation of water in an extended system of piping, and for returning all condensation to the boilers as a measure of economy. This contract, comprising engines and steam-loops, was awarded to Westinghouse, Church, Kerr & Company, and comprises, up to date, seven independent Westinghouse compound engines, as follows: One of 80 H. P., one of 130 H. P., four of 200 H. P. each, and one of 330 H. P., each protected by a separator and steam-loop. A central boiler plant of high-pressure boilers supplies steam to these engines, most of which are several hundred feet distant, and also to sundry pumps and other steam machinery. The steam mains, which commence with a diameter of 14 in., are laid in an interesting and original manner. To go overhead was out of the question, and the problem of an underground line was a difficult one, on account of the nature of the ground, which, for the most part, is soft silt, flooded at high tide. A subway was therefore constructed by sinking a large steel tube of sufficient diameter to carry all the steam and water pipes with the steam-loop returns, and allowing ample head room for inspection. Y branches and eccentric reducers are freely used, and expansion is taken care of by copper bends at the angles. The steel subway itself is used as a hot-air duct, distributing from an indirect system with fan-blast for heating the various buildings. High-pressure steam at about 150 lbs. is carried through the entire system. The return system at present consists of 6 separators and 13 steam-loops, all entering into one common 4-in. return, which lies parallel to the steam pipe in the steel tunnel above described.

Lead Pipe Bored by a Worm.—In a note recently published in the German *Sanitary Engineer*, Herr K. Hartmann gives an instance of a lead pipe pierced by a larva of the wood wasp, the insect being actually found with its head in the hole pierced by it. A workman employed by the firm of Naruhn & Petsch was called in to repair a defective pipe which had been injured on a previous occasion, as was reported, by a "nail-hole" occurring in a soldered joint. This time the worm causing the mischief was found in place. The hole on the exterior of the pipe was of a rounded form, 7 millimeters long by 4 mm. wide, and the penetration was through the entire thickness of the metal. By quotations from various publications it is shown that, though of rare occurrence, well-authenticated instances of similar injuries by insects are on record.

A New Gold-Colored Alloy.—Herr T. Held has invented an alloy of copper and antimony in the proportion of 100 to 6 which is made by melting the copper, and when at the right heat adding the antimony; and when both are melted and intimately mixed, fluxing the mass in the crucible, with an addition of wood-ashes, magnesium and carbonate of lime, which has the

effect of removing porosity and increasing the density of the metal when cast. The alloy can be rolled, forged and soldered in the same manner as gold, which it very closely resembles when polished, the gold color being unchanged, even after long exposure to ammonia and acid vapors in the atmosphere. It is also much stronger than gold. The cost of the alloy in the ingot is about 25 cents a pound.—*Dingler's Polytechnische Journal.*

Copper Production of the World.—The following figures, compiled in Paris and published in the *Revue Scientifique*, give the copper production of the world for 12 years past. The several columns show the total output, and that of the three more important copper-producing countries :

YEAR.	Total Product.	United States.	Chili.	Spain and Portugal.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1879............	151,963	23,350	49,318	33,361
1880............	153,959	25,010	42,916	36,313
1881............	163,369	30,882	37,989	39,258
1882............	181,622	40,470	42,909	39,560
1883............	199,406	51,570	41,099	44,607
1884............	220,249	64,700	41,648	46,415
1885............	225,592	74,050	38,500	47,873
1886............	217,086	69,805	35,025	49,653
1887............	223,078	79,109	29,150	53,706
1888............	258,026	101,710	31,240	56,450
1889............	261,650	105,774	24,250	54,800
1890............	269,685	116,325	26,120	52,333

With the exception of two years the total output has shown a steady growth, and that of 1890 shows an increase of 77½ per cent. over 1879. The product of the Spanish and Portuguese mines has shown a steady increase, but has not quite kept up with the total, that of 1890 showing a gain of 56⅞ per cent. only over 1879. The Chilian production has varied considerably, but in the opposite direction, 1890 exhibiting a loss of 47 per cent. from 1879. In the smaller copper-producing countries the industry has advanced ; taken together their output in 1890 increased 62⅝ per cent. over 1879.

The great increase has been in the United States, which, with the exception of one year, has shown a large and constant growth in this respect. So great has this been that the output of 1890 shows a gain of 398 per cent. over that of 1879. This gain is further shown by the fact that in 1879 the United States furnished 15 per cent. of the total supply of the world ; in 1883, it supplied 26 ; in 1887, it had 35½ ; and in 1890 no less than 43 per cent. Those years are taken periodically, and not on account of any exceptional production.

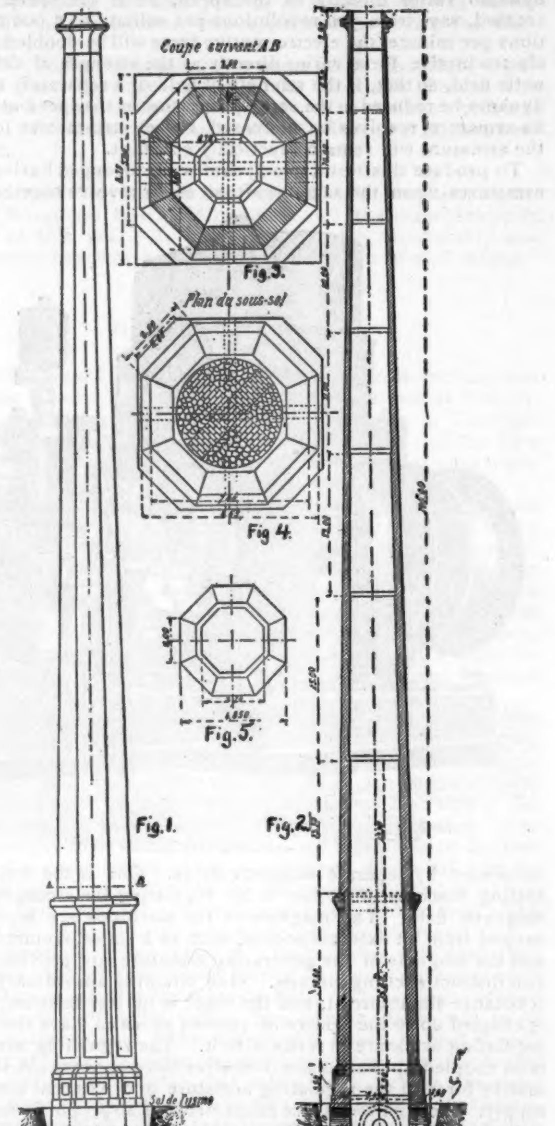
The consumption of copper has increased in about the same degree as the production ; and the surplus stocks are not now proportionally greater than they were 12 years ago.

London-Paris Telephone.—Since March last a telephone line has been in regular operation between London and Paris. A special cable was laid under the English Channel for this line, which consists of the land line from Paris to Saugatte, near Calais, about 200 miles ; the cable, 26½ miles, and the land line from St. Margaret Bay, near Dover, to London, about 50 miles. Between the central stations in London and Paris conversation is easily carried on, the line working very well ; but some trouble has been found in the connections with the local city circuits, and there are no private telephones connected as yet.

The tariff is high, the charge being 10 francs in Paris or 8 shillings in London—nearly $2—for the use of the line for a "period ;" the time of the period has been fixed at three minutes only.

Water Power and Electric Transmission.—The Cœur d'Alene Company, of Idaho, have under construction a power plant, which considering its extent and the variety of work to be operated, will be one of the most important installations of a mining character yet made. The plant is located on Cañon Creek, about 1½ miles from the mill and mine of the company, and consist of two 225 H. P. Edison generators driven by Pelton wheels running under 690 ft. head. The mill machinery will be driven by an 80 H. P. motor connected direct to the main shaft. The compressor will be driven by a 60 H. P. wheel connected to the fly-wheel. The hoisting machinery will also be run by a 60 H. P. Pelton wheel geared direct to present driving shaft. The pump situated on the 500-ft. level will be driven by an 80 H. P. Pelton wheel directly geared. The entire plant has been planned to connect with the machinery already in use and now operated by steam. It is expected that the operating expenses of the company will be reduced fully 50 per cent., when the new power station is in running order.—*Industry, San Francisco.*

A Tall Chimney.—The accompanying illustrations, from *Le Genie Civil*, show one of the tallest chimneys in the world, its height being exceeded only by six others now in existence. It is a central chimney provided for the forges at the Naval Steel Works, at St. Chamond, France. This chimney has the advantage of being founded upon a rocky base which is there found at only a short distance below the surface. Its height above the surface of the ground is 100 m. (328 ft.). The general design and the division into sections are shown in the illustrations in which the dimensions are given in meters. Fig. 1 is an



elevation ; fig. 2 a section ; fig. 3 a cross-section on the line *A B*, fig. 1 ; fig. 4 is a plan of the foundation, and fig. 5 a plan of the top or coping. Figs. 3, 4 and 5 are on a larger scale than figs. 1 and 2. The chimney is octagonal in shape, as shown in the drawings. The general dimensions are as follows : Height from the surface of the ground 100 m. (328 ft.) ; exterior diameter at the base 7.40 m. (24.27 ft.) ; at the summit 3.25 m. (10.66 ft.) ; interior diameter at the base 5.15 m. (16.89 ft.) ; at the summit 2.70 m. (8.86 ft.) ; thickness of wall at the base 1.125 m. (3.69 ft.) ; at the summit 0.325 m. (1.06 ft.). The ratio of the diameter to the height is 1 to 135. The calculated stability for the highest wind pressure which can be expected in that region is 2.20, the normal stability just sufficient to resist the wind being assumed at 1. This chimney has been built with great care as to material and construction, and is certainly very graceful in its proportions.